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GEOLOGY.—*The emergence of ideas as illustrated from geology.*[1] GEORGE H. ASHLEY, State Geologist of Pennsylvania. (Communicated by ROLAND W. BROWN.)

Geologic ideas emerged slowly because primitive man was curious only in matters affecting his personal welfare; because the earth's major features seemed too permanent to suggest that they had evolved from other forms or conditions; and because some peoples held the concept of a God able to create the heavens and the earth and to control or change them at will—a concept not yet extinct.

On the other hand the Greeks, Romans, and some others, worshipped a galaxy of gods until they tired of them. These gods, like the genii of the Arabian Nights, had magical but limited powers which did not include creating stars or upheaving continents. So, thrown on their own resources, the Greeks and Romans began to observe nature and theorize on her ways. As a result many ideas of vast import today first emerged over 2,000 years ago. As early as the sixth century B.C. Xenophanes finding sea shells far inland saw evidence that the sea had once covered that area. Aeschylus in 525 B.C. glimpsed the idea of progress when in *Prometheus Bound* he described primitive man as living "like silly ants beneath the ground in hollow caves unsunned." Before 400 B.C. Herodotus, Democritus, and others were arguing that the earth was round, the center of a revolving universe, composed of atoms and subject to natural law. They recognized changes produced by erosion and sedimentation. Later Plato, Aristotle, Pliny, and others added their bit although all their contributions made only a slight beginning.

Then came the Dark Ages. The Greco-Roman world was conquered from the northeast by the barbarians and from the southeast by the Christians. The Christian concept of an all-powerful God did not encourage the study of earth forces and laws. For a time culture passed to the Arabs, and in Europe the partly formed ideas concerning the earth awaited a more auspicious time for further development. Starting with their rebirth let us trace the evolution of a few of these ideas.

[1] Address delivered before a joint meeting of the Washington Academy of Sciences and the Geological Society of Washington, November 19, 1936. Received December 15, 1936.

EROSION AND THE EARTH'S SURFACE

That rivers dig their own valleys is one of the large and useful concepts of modern geology. As with other ideas I shall take up, this has not yet completely emerged, and 100 years ago Benjamin Silliman, of Yale, one of America's great scientists, refused to accept it. The Greeks recognized more than two thousand years ago that valleys were silting up, deltas were extending, that floods produced minor changes along stream-channels and so on. These ideas though lost sight of in Europe, were preserved among the Arabs of North Africa. Thus in 1000 A.D. Avicenna, an Arab, translated Plato into Arabic and seems to have been the first to recognize that while some mountains were upthrust to the accompaniment of earthquakes, some were left in relief as erosion etched away the softer rocks surrounding them. Europe was not then reading Arabic.

The Crusades brought a change. The forest dwellers of western and middle Europe saw in the East a civilization superior to their own, some of which they brought back. Trade with the East developed and wealth accumulated, especially in Italy. Then came the Renaissance. Men began to explore the earth. The classics of Greece were restudied. Outstanding at that time was Leonardo da Vinci, born in 1452, who to his other accomplishments added a study of the earth. Thus he recognized that the river Po was building the plain of the Po valley; that high-level gravels were deposited when the river ran at that elevation long ago.

The idea that valleys were carved by the rivers in them encountered two almost insurmountable obstacles: first, the earth's obvious stability and lack of change as far back as man's memory or traditions went; and second, the concept of a six-day creation dating about 4000 B.C. Specifically the Mediterranean and the lands around it had not changed materially in the memory of man. Roman bridges 1,500 years old revealed no change in the river banks. The individual man saw no change in his landscape.

Two hundred years passed before the idea began to make headway that rain and rivers might produce major changes in the earth's surface. Nicholas Steno and John Ray saw that, given time enough, these forces would ultimately reduce the land to sea level. But lack of available past time still handicapped a proper concept of the origin of the earth's present features. Only catastrophic events would serve. Another century passed before observers here and there saw and recorded changes going on before their own eyes. De Saussure in

Switzerland, Guettard in France, and others began to realize that erosion gradually modifies the face of the earth.

Then Buffon broke the chains of time and finally James Hutton in 1785 boldly declared that given time enough the forces at work about us were adequate to account for all we could read in the rocks. Even then another half century passed before many leading geologists completely accepted the idea.

Hutton clearly pointed out that not only was erosion molding the face of the earth today but that rocks revealed many previous periods of long erosion followed by sinking and the laying down of thousands of feet of additional sediments. At the beginning of the twentieth century W. M. Davis recognized that sometimes, after a long period during which the earth's surface was reduced almost to a plane or "peneplane," uplift instead of sinking might follow, with the gradual destruction of the plane, which however might still be recognized in flat mountain tops or in other flat highlands bevelling rocks of different hardnesses. Then for a time every flat surface anywhere and at many elevations was called a peneplane until there was a veritable plague of peneplanes.

Within recent years came a clearer recognition that though erosion works slowly it takes no vacations and slights no parts of the earth's surface, even peneplanes. It was recognized that flat mountain tops often coincide with flat-lying resistant strata, or with upturned strata so uniform in character, thickness and structure that though reduced hundreds of feet they may still reflect a former peneplane. Evidence is clear that some monoclinal mountains have retreated many miles without losing their level summits. So most of the peneplanes have faded out, though many parts of the earth still reveal one or more.

Coming to the present. What next? Next we must reduce our qualitative knowledge of erosion to quantitative. The history of a river is revealed in the contours of its valley. At present we are content to name the changes that have taken place. The next logical step is to measure them. That will require care in the selection and evaluation of the criteria but offers no insurmountable obstacles. In particular we need to study the differential effect of erosion. If we say that, based on studies in the Mississippi, the surface of that basin is lowered one foot in 4,000 years, we do not mean that the whole surface is lowered that much. Flat, gravel-covered areas may be lowered very little, a fraction of an inch; intermediate areas may be lowered a foot; areas of high relief may be lowered several feet and river channels in areas of recent uplift may be cut down many feet; as in

the San Juan Mountains where 2,500 foot canyons were formed between two uplifts, both of Pleistocene age. As another example, Sir Arthur Keith makes the Piltdown skull a million years old. It was found in plateau gravels 80 feet above the Ouse River cut in rocks of Cretaceous age. If that is a region of recent uplift, it is conceivable that the Ouse River might have deepened its valley 80 feet in 20,000 to 100,000 years, depending on all the factors involved. The matter should be completely solvable, as should be any other questions in which erosion is involved. But the answer demands vastly more facts than we now have.

FOSSILS AND WHAT THEY TELL

Passing the Greeks and Romans who correctly interpreted fossil shells as the remains of past life and as indicating the former presence of the sea where they were found, and skipping the succeeding Dark Ages, we come again to Leonardo da Vinci in the fifteenth century, who recognized the true organic nature of fossils. To account for sea shells hundreds of miles inland involved changes in the earth's face contrary to all human experience and tradition; and so for several hundred years a royal battle raged between those standing for their organic character and those finding other explanations, some even charging that the devil put them there to confound the pious. But as knowledge of fossils grew, there could be only one outcome of such a battle and by the end of the eighteenth century their organic origin was acknowledged by all except Werner, a mineralogist, and his disciples.

Meanwhile Guettard and others had found that fossils commonly characterized certain rocks, that they revealed the climate and physiographic conditions under which the rock was laid down, and, using fossils, they began to make geologic maps showing the outcrop of the strata. William Smith thus made a geologic map of England; but American geologists, many of them influenced by Werner, were slow to take advantage of fossils until the New York State Survey was established.

But fossils were leading down other roads. They revealed the former existence of plants and animals now extinct. Soon the outlines of the long ascent of life began to emerge. As vast numbers of fossils were found and men noted that in places the whole fauna changed from one layer of rock to the next, they began to speculate on the origin of these new and later forms. Some saw successive faunas and floras wiped out by catastrophies, followed by a wholesale creation of new

faunas and floras. Others, like Lamarck, felt that somehow the later faunas had evolved from the earlier. The idea was not new. By the middle of the nineteenth century that idea had become dominant, though as yet no one had suggested how it could be brought about. Then Darwin and Wallace offered a mechanism that seemed adequate to account for the origin of the new species.

I need not tell you of the quick acceptance of that idea by the few and its general rejection by the many even to this day. We come to the present. What next? You know the tremendous importance of fossils today in all stratigraphic work, but I believe that they may perform another large service. I may be stepping on the toes of some if I suggest that biologists experimenting with fruit flies or other living forms miss entirely the fundamental factors in evolution, one of which is time. Marble is not flexible in the laboratory but I have seen thin marble slabs in cemeteries bend under their own weight—with time. In the laboratory time may be simulated for some things by "speeding up" processes, but not for others. Recent biological studies are valuable for a better knowledge of heredity; but the evidence is clear that while all life tends to adjust itself to its environment, it reveals no tendency to advance toward man. It is suggested that the steps in the ladder to man have been unique, each step occurring only at one place and at one time. It is not clear yet whether these steps were large, by mutations, or small and infinite in number. In either instance the question naturally arises as to their cause. Chance or purpose? Any attempt to get help from science on the answer to that question demands more knowledge of fossil life. It alone reveals the full play of time. Again we need more facts.

GEOLOGIC TIME

One of the astounding ideas given the world by geology is that of the enormous duration of earthly time. This was the missing factor in all early thinking about the earth. First estimates were based on supposed genealogic records, traditions and what not. All early peoples reckoned human history as very short, a few thousand years at most, and earth history as still shorter. The two periods were like the time it takes a man to build his house and the time he lives in it. The earth was built for man; the sun and stars were its exterior decorations. Even in the seventeenth century when Nicholas Steno, followed by others, first began to read successive events in the rocks, they felt impelled to compress them into the accepted span of earth history. Descartes and Leibnitz, who postulated the earth as derived

in molten condition from the sun and as having cooled since, seem not to have committed themselves to time figures. Apparently that remained for Buffon, in the eighteenth century, after testing the rate of cooling of cast iron balls. He frankly declared that the six days of Scripture meant periods, to be as long as the facts demanded. He estimated 75,000 years from the beginning of the earth. Probably James Hutton was the first to realize that his interpretation of the rocks demanded vast stretches of time. As Playfair wrote, after seeing a cliff section with Hutton and Sir James Hall in a boat: "The mind grows dizzy looking so far into the abyss of time."

From then on an increasing number of people grasped the idea of geologic time, as illustrated by Lamarck's statement: "For nature time is nothing." While most geologists contented themselves with pointing out the evidence of vast time, a few dared to make estimates in years. As far back as 1715, Halley suggested determining the age of the Caspian sea by noting its increased saltiness over a period of years and computing its age from the total saltiness. As such an experiment might take centuries, it was not tried. In 1860 John Phillips started off with 38 million to 96 million years. But about the same time Lord Kelvin, Tait, and others, calculating the rate of the earth's radiation of heat, argued for 5 to 10 million years. Lyell had estimated the time required to lay down the Joggins coal measures in Nova Scotia at from 375,000 to 2,000,000 years. Later he estimated or guessed at 240 million years as necessary for historic geologic time. For a generation the dispute raged, estimates by geologists in the 1890's ranging as a rule under 100 million years, though Geikie in 1899 estimated from 100 to 400 million years.

In the early 1900's new means of estimates came from two directions, Sollas, Becker, and others, using the salt of the sea, contented themselves with small numbers, 30 to 80 million years; while Rutherford, using an entirely new method, in 1908 announced 500 million years as the time from the beginning of the Cambrian. The new method was based on studies of radioactive minerals and is today too well known to require more than reference here. As continued research appears to give concordant results, there is today a tendency to accept the general figures supplied by these studies, which indicate an age of roundly 500 million years from the beginning of Cambrian time.

Today, however, we are asking for more accurate measures for geologic time, especially, as previously suggested, in matters bearing on the antiquity of man. While many methods have been used in

these studies, most satisfactory results are being achieved by correlating records of rhythmic sedimentation. These are of several kinds: the simplest and most satisfactory are varves or the annual layers of sediments deposited in ponded waters. Varves reveal not only the number of years represented by any such deposit but may reveal a seasonal record from year to year that permits correlating the varves of one area with those of another. Similar studies are now being made of fine deposits of all geologic ages and are not only yielding time estimates but in some instances are helping to identify key horizons in stratigraphic sections otherwise apparently homogeneous. In highly folded strata, the detection of such key horizons is essential to eliminate re-counting beds repeated by the folding.

Recently attempts have been made to identify larger cycles. Thus the four or more glacial advances suggest some kind of rhythmic series. The large number of coal beds usually found in coal measures accompanied by the underclay and other beds has suggested a cycle of events, climatic perhaps or of rhythmic earth movements. These are being studied to determine, if possible, the cause of the seemingly rhythmic movements. Efforts are also being made to determine if there may not be some cause for those still larger movements that result in geosynclines with heavy sedimentation, followed by apparent contraction with rock folding and mountain making.

Few results have yet appeared except with varves. But there is a growing feeling that more knowledge will reveal the interaction of great forces, perhaps astronomic in character and therefore measurable as to time, that will ultimately permit us to refer all geologic history to a definite and complete time scale, much as we do human history since man began to keep records of his comings and goings. But here again our crying need is for facts.

GLACIERS

Let us turn for a moment to something lighter. One reason why many early geologists refused to accept the idea that rivers had cut their valleys, was the presence over all of northern Europe and northern America of great bodies of debris called "The Drift" or "Diluvium," sand, gravel, clay and rock, piled helter-skelter over the land. The only plausible explanation was a vast flood. Why should not such a flood also have gouged out the valleys? True, Playfair in 1802 suggested ice; but the drift covered hills and mountains as well as valleys. Ice was inconceivable as a cause. But about 1830 two Frenchmen, Venetz and Charpentier, traced the tracks of ancient

Alpine glaciers from the Alps far out over the Swiss plains. In 1836 Louis Agassiz went over the ground with them and at once noted the resemblance of these deposits to the drift of other areas. Visiting England he was convinced that ice—glacial ice—had once pushed over all the British Isles. Von Buch, it is said, "could hardly contain his indignation" at the idea. But once delivered, the idea would not down. Agassiz persuaded Buckland, the English geologist, to visit the Swiss area with him and Buckland returned converted. Lyell followed. But it took many years to convert all geologists to the idea.

Then came the question: Whence and why the ice? Two theories arose; one that the drift had been deposited by floating icebergs while the drift-covered land was submerged beneath the sea. The other that from whatever cause, ice had accumulated at centers of distribution to such depth that it flowed outwards hundreds of miles over land and sea. Lyell in 1845 suggested a compromise that islands of floating ice had encroached on sinking lands. He assumed that from some cause glacial cold existed all over the northern hemisphere. Many theories were offered to account for this condition, from land changes affecting the Gulf stream and other oceanic currents to Croll's theory relating it to the shifting of the polar axes or variations in the heat of the sun. Obviously the localized character of the centers of ice accumulation, both in the recent Ice Age and in previous ice ages, ruled out any theory that affects the earth as a whole. On the other hand the existence of great mountain glaciers in the Alps, Sierras and other mountains outside the glaciated areas during the Ice Age rules out purely local causes. Recent physiographic studies revealing 10,000-foot canyons of Pleistocene age off our coasts and elsewhere, growing knowledge of other tremendous earth movements in Pleistocene time, as revealed in the Himalayas, Andes, Atlas, and other mountains, evidences that between the several glacial advances our coasts were flooded, are all throwing new light on the problem and may lead to its solution. But in the meantime we need more facts.

THE STRUCTURE OF THE EARTH

Finally, for I do not want to keep you here until the opening of the Quinternary Age, it may be of interest to trace briefly the emergence of present ideas about the structure of the earth. Early man took the earth for granted as it was. If he stumbled over the protruding edge of a layer of rock he probably swore in Egyptian, Hebrew or Greek as the case may be and let it go at that. Just when men began to observe

layers of rock, other than layers of sand and gravel, is unknown. When they did they took them for granted as we probably do the mechanism of our new radio. If the rocks stood up on end, men assumed that they were made that way.

But the finding of fossils in certain rock layers suggested that these rocks had been deposited as sediments in the sea. At first it was thought that these beds and their enclosed life remains were laid down by the Flood. Apparently it was not until Nicholas Steno in 1669 published his treatise on the rocks of Tuscany describing six episodes in the geologic history of that area that men began to realize that the rocks were the result of earth forces and revealed a story. This idea made headway slowly. Here and there men began to observe distinctions in rocks and in the eighteenth century Peter Pallas, noting granite and schists in the center of the Urals, flanked by highly dipping rocks and those in turn by other rocks having low dips, distinguished the three series as primary, secondary and tertiary. Still it was commonly held that steeply dipping strata were formed that way. A theory to account for the many layers of rock at all elevations assumed that in the beginning an ocean as deep as the highest mountains covered the earth. As its surface gradually sank layers of rock were deposited. Where the water went to nobody knew, but presumably into the earth to form vast reservoirs as a source of springs. Steno held that the collapse of these reservoirs turned the overlying rocks on end, as they were often observed to be. But though this explanation was wrong, Steno had insisted that the upturned strata had been turned up by earth forces and, though generally denied, the idea slowly took hold, until Hutton in 1785, 150 years ago, presented clear evidence that granite and other igneous rocks had pushed their way up through the overlying beds, and not only penetrated them but turned them up on end and even exerted such a tremendous side thrusting effect as to fold them some distance from the upthrust.

As Rogers in Pennsylvania, Heim in the Alps and others began to describe and figure wide areas of highly folded beds many thousands of square miles in extent, often with overturned folds or thrust faults driven many miles over the tops of the other rocks, it became obvious that other factors besides igneous intrusion were involved. This led to the theory that, due to loss of heat from the interior, the earth's core was shrinking while its crust, maintained at a constant temperature was not, and that therefore it must in time buckle on the interior as does the skin of a dried apple.

Meanwhile, however, the discovery of tillites or ancient glacial deposits, some of Pre-Cambrian age, upset the idea of continuous cooling. Then came the discovery of radioactivity and the conclusion that radioactivity would not only explain the slow cooling of the sun but also the slow cooling of the earth and suggested that the earth was not actually cooling at any such rate as had been assumed. Calculation had indicated that, cooling by heat radiation alone, the sun should have become chilly long ago and that the earth could not be over ten or twenty million years old. Other difficulties also arose, such as enormous thrust folds in the Alps, and evidence of crustal extension or stretching, as indicated in rift valleys.

Then isostasy came into the picture—the idea that there is an isostatic balance between sectors of the earth's crust, so that light rocks in elevated areas are balanced by heavier rocks in relatively low areas, as under the sea bottom. The only way such a balance can be maintained under changing surface load is by the transfer of rock below the surface from one area to another. Thus, as a mountainous area is lowered by erosion, its weight is reduced, while the area receiving the sediments has its weight increased. According to isostasy, a flow of deep seated plastic rock from the area of sedimentation to the area of erosion, will not only maintain the balance but will account for the gradual and continued elevation of the area of erosion and the gradual, continued sinking of the area of sedimentation. But which movement came first and what started it?

Recently isostasy has been criticized from many angles. All through past time shores have advanced and retreated; but an advancing shore means uplift in the region of loading and a retreating shore means sinking in the region of unloading. Furthermore our growing knowledge of stratigraphy has shown tremendous gaps in the sedimentary record during which the area of sedimentation either stood stationary over long periods and received no sediments or was lifted above sea level and actively denuded. These facts raise questions as to whether surface loading and unloading is a primary or secondary factor. Isostasy does not seem to account for the vast surface overthrusts such as the 75-mile Alpine thrust, the 35-mile or more Bannock overthrust of Idaho and Wyoming, the overthrusts of Glacial National Park, and many others.

I will not attempt to lead you through the mazes of the "undation" theory of Stille and others, in which, starting with a variable differentiation of the acidic from the basic rocks in a subsurface gabbro-

like mixture, there follows a theoretic succession of events producing the surface features we observe, even to the great overthrust faults. It is certainly an ambitious attempt to explain the earth's major crustal features but it needs more study of all the facts involved, not overlooking the factor of friction. According to this theory the medial ridge of the Atlantic is the beginning of a new continent.

Recently Alfred Wegener, struck by the resemblance of the east shore line of the Americas to that of the west shore line of Europe and Africa, suggested that at sometime in the past these continents were united, but subsequently drifted apart. He found some resemblances in the direction and age of the mountains on both sides of the Atlantic. This theory helped to explain how in many ages animals and plants living on the east side of the Atlantic could have left their remains on the west side also, before the days of arks or other boats, and obviated the building of land bridges. The physicists, however, raised questions of friction and other mechanical difficulties so that the theory has not been widely accepted.

Tokuda, of Japan, noting chains of islands or chains of mountains, making great arcs, as in the Aleutian islands, has been experimenting to show that these might have been formed by great sliding crustal fans. Imagine an old land bridge between Alaska and Asia taking a slide southward, pushing up the Aleutian Islands at its toe and leaving a depression behind now filled by the Behring Sea. The Okhotsk Sea, Sea of Japan, East China Sea, South China Sea and Philippine Sea, are each thought to fill the voids left by other great slides, not to mention the Caribbean Sea and others. It may be true but at first it takes your breath away.

No other field of geological investigation is today more active in producing new ideas, many quite startling and upsetting to old conclusions. One of the old ideas now before the court of inquiry is that great periods of mountain building were of limited duration. It is generally recognized today that most of our mountains are not simple mountains of folding, but are due to subsequent and recent uplift, sometimes with faulting, of old areas of land, underlain or not by folded rocks. Nearly all the high ranges bear traces of past peneplanation on their shoulders.

But back of that, evidence of persistence of structures is accumulating all over the world. We have long known that the Cincinnati Arch, as we call it, was not a single uplift. The Himalayas began to form in Cretaceous time at the north, continued to form in Eocene

and lower Miocene time and have reached their present height only recently. In England we find Cretaceous folding in places following the underlying Carboniferous folding, with peneplanation between. In the Appalachians, evidence is accumulating that folding began in Ordovician time or earlier, and it begins to look as though the eastern Appalachians had largely been folded by the beginning of Silurian time or continued to be folded during Post-Ordovician time and thus became the source area for the later Paleozoic rocks. Finding Devonian fossils in "Pre-Cambrian" schists in New England is only one of the disturbing new facts.

This is not the time or place to go into details. I only mention some of the new theories, to show how ideas on orogeny are struggling to emerge. These studies are revealing new patterns or a framework in the earth's major features. New facts are complicating old problems, but they also serve to define more clearly those problems, until, as C. F. Kettering would say, "Some day we will have defined our problems so exactly that we shall have solved them."

Without pursuing the matter further, we realize today that our urgent need in every geological field is for facts and more facts. Our knowledge of the earth is just about where the knowledge of the body was two or three hundred years ago. Unfortunately our efforts to penetrate the mysteries of the earth's interior are comparable to attempting to make an autopsy of a man's body with his clothes on.

PALEONTOLOGY.—*A specimen of* "Crassatellites" *from the St. Marys formation of Maryland.*[1] W. C. MANSFIELD.

Dr. S. F. Blake, U. S. Department of Agriculture, recently collected a left valve of the genus "*Crassatellites*" from the St. Marys formation at Chancellor Point, St. Marys River, Maryland, and kindly turned it over to me for identification. The bluish sandy clay deposit at Chancellor Point was referred by Shattuck[2] to zone 24, or the highest zone, of the St. Marys formation of Maryland.

The specimen in hand is interesting because no species or subspecies of "*Crassatellites*," to my knowledge, has heretofore been identified from the St. Marys formation of Maryland, although two subspecies —"*C.*" *meridionalis surryensis* Mansfield and "*C.*" *undulatus urban-*

[1] Published by permission of the Director, U. S. Geological Survey. Received December 24, 1936.

[2] SHATTUCK, G. B., Maryland Geol. Survey, Miocene, p. lxxxv, 1904.

naënsis Mansfield (formerly called a subspecies of *meridionalis*), have been obtained from the St. Marys formation of Virginia, the former taken from the basal bed consisting of a blue sandy clay exposed in the right bank of the James River, 1½ miles below Claremont Wharf; and the latter from a stratigraphically higher sandy deposit at Urbanna.[3] The Maryland specimen, though slightly corroded in the umbonal region, appears either to be *"C." meridionalis surryensis* Mansfield or a closely related form. The slight differences observed between the Maryland form and the Virginia subspecies is that the Maryland form is smaller, thinner, more quadrate, and the nepionic undulations extend radially about 3 mm farther. The dimensions of the Maryland specimen are: length, 70 mm; height, 50 mm; distance of umbo to the anterior end, 30 mm.

With only one specimen in hand from the St. Marys formation at Chancellor Point, I do not think a new subspecific name is warranted unless more specimens are collected from this horizon that show the assumed differences to be constant.

A right valve of a *"Crassatellites,"* so far unidentified, was taken a number of years ago from a well at a depth of 130 feet at Crisfield, Sommerset County, Maryland. This specimen is corroded in the umbonal region; however, relying on the other better preserved parts of the shell, it appears to be the same as the subspecies from Virginia—*"C." meridionalis surryensis*. The base of the St. Marys formation in this well is estimated to be at a depth of about 240 feet.

At present the following species or subspecies of *"Crassatellites"* are represented at different horizons of the Chesapeake group: *"C." melinus* (Conrad), Calvert formation; *"C." turgidulus* (Conrad), Choptank formation, zone 17; *"C." marylandicus* (Conrad), Choptank formation, zone 19; *"C." meridionalis surryensis* Mansfield, St. Marys formation, Maryland (?) and Virginia; *"C." undulatus urbannaënsis* Mansfield, uppermost St. Marys formation, Virginia; *"C." undulatus cyclopteras* Dall, Yorktown formation, zone 1 and later; *"C." undulatus* (Say), Yorktown formation, zone 1, to Duplin marl (uppermost Miocene).

The name *"Crassatellites"* is placed in quotation marks here as the nature of this name has been indicated by Iredale (Mal. Soc. London Proc., vol. 14, p. 206, 1921) to be unsatisfactory. Consequently, the correct generic names to be applied to the east coast Miocene forms cannot be given until a study of the family Crassatellidae is made.

[3] MANSFIELD, W. C., U. S. Nat. Mus. Proc., vol. 74, art. 14, pp. 8–9, 1929.

STRATIGRAPHY.—*The stratigraphic significance of* Kummelia, *a new Eocene bivalve genus from New Jersey.*[1] LLOYD W. STEPHENSON, U. S. Geological Survey.

The tube of a boring bivalve mollusk from the Vincentown sand (Rancocas group, Eocene) was described by Gabb (1) in 1860, under the name *Gastrochaena americana*. At that time the Vincentown was classed as Upper Cretaceous, and it was not until 1928 that Cooke and Stephenson (2) reassigned the formation, together with the underlying Hornerstown marl of the Rancocas group, and the overlying Manasquan marl, to the Eocene. Tubes of boring mollusks found in beds of undoubted Upper Cretaceous age, in the Atlantic and Gulf Coastal Plain, were referred to Gabb's species by Gabb himself and by Weller and others, but, as shown below, this identification was erroneous.

In 1861 Gabb reassigned his *Gastrochaena americana* to his new genus *Polorthus* in the belief that the tube was a conch and pertained to a gastropod near *Vermetus*. In 1872 Gabb reassigned *Polorthus americanus* to the Cephalopoda and made it the type of a new family, Polorthidae; this was done because he had come to believe that the suture-like grooves separating the annulations on the exterior of the tube indicate a chambered, septate conch.

That Gabb was mistaken in both of these reassignments, and that his *Polorthus americanus* is an external, protective calcareous tube secreted by a boring bivalve mollusk, can now be demonstrated. The present author has had the good fortune to find in the tubes specimens of the bivalve mollusks responsible for the construction of the tubes, both those in the Vincentown sand and those in the Upper Cretaceous sediments; the evidence afforded by these shells demonstrates clearly that the animal that secreted the Eocene tubes is both generically and specifically distinct from the one that built the Cretaceous tubes. The differences which serve to separate the two kinds of shells and tubes are indicated in the formal description given below. The Cretaceous shells and their tubes are strikingly like those of the true *Gastrochaena* Spengler, a Recent bivalve inhabiting the waters of the Indian and West Pacific Oceans, whereas both the Eocene shell and its tube are essentially different from *Gastrochaena*. Although the shells found in the tubes from the Eocene are similar in form to *Roscellaria* Blainville, a Recent shell, the Eocene tube is

[1] Published by permission of the Director, U. S. Geological Survey, Washington, D. C. Received December 18, 1936.

strikingly different from that of *Roscellaria*, for which reason, and also because of the great separation in time, it seems reasonable to assign the Eocene shell to a new genus. The name proposed is *Kummelia*.

One incomplete tube of a boring mollusk, found by Dr. John B. Reeside, Jr., September, 1931, in the Piscataway member of the Aquia formation (Eocene), in a road cut just east of the West Branch of Patuxent River three fourths of a mile west of Oak Grove, 2.6 miles west of Leeland, Prince Georges County, Maryland (3), is essentially like that of *Kummelia americana* (Gabb); the shell itself was subsequently uncovered within the tube and it confirmed the identification. The shell and tube are shown in Figures 6–8. The road cut exposes about 15 feet of greensand, several layers of which are indurated. The tube was found in a loose fragment of one of the indurated layers; associated with the tube in the same piece of rock were several shells of *Terebratula harlani* Morton.

The finding of *Kummelia americana* (Gabb) in the Aquia formation of Maryland affords further confirmatory evidence of the Aquia (Eocene) age of the Rancocas group of New Jersey. The Oak Grove locality is stratigraphically well below a zone in the Paspotansa member of the Aquia formation (3) from which 23 species of Bryozoa have been recorded by Canu and Bassler (4); 6 of the 23 species are common to the Vincentown sand. Since the Vincentown has yielded 85 species of Bryozoa, this relatively small number of common species does not necessarily indicate exact age equivalency of the containing beds in Maryland and New Jersey; but there is a reasonable presumption that they do not differ greatly in age, and the position of the Oak Grove locality below the bryozoan zone suggests that it is of Hornerstown age.

In the summer of 1936, Mr. P. E. Cloud of the U. S. National Museum, made a collection of fossils from the Hornerstown marl in a pit of the Zeolite Chemical Company, 2 miles north of Medford, Burlington County, N. J. The fossils are mainly in the form of internal molds and include: An unidentified coral (common); an unidentified sponge (numerous); *Cucullaea* sp. (numerous); *Venericardia* (of the *planicosta* group); *Meretrix*?; *Polinices* sp.; *Pleurotomaria*?, and several unidentified gastropods. Of the forms mentioned the *Venericardia* may be accepted as satisfactory evidence of the Eocene age of the Hornerstown marl. The *Cucullaea*, though specifically indeterminate, has a form suggestive of *C. macrodonta* Whitfield from the Midway group (Eocene) of the Gulf region.

In recording this new evidence of the Eocene age of the Rancocas group, it is appropriate to call attention to evidence presented in three papers that have appeared since the publication by Cooke and Stephenson (2).

In 1930, Wetmore (5) critically reviewed the stratigraphic occurrence of eight species of fossil birds from supposed Cretaceous beds in New Jersey. He found that all came from the Hornerstown marl, the lower of the two formations composing the Rancocas group, and he concludes:

> From what has been said above it is evident that all of the supposed Cretaceous birds of the New Jersey marl beds are in reality from Tertiary deposits since they appear to come from the Eocene. They will be so indicated in the list of fossil birds to be included in the fourth edition of the "A.O.U. Check-List" now in course of preparation. With these forms allocated in the Eocene there is more logic in including them under families of birds with species existing today, procedure that to the writer has seemed dubious while they were considered of Cretaceous age since it is his present belief, based on what is known of the Hesperornithiformes and the Ichthyornithiformes, the only Cretaceous birds in which the skulls have been found, that all Cretaceous birds possessed teeth, and were for this and other reasons not so closely allied to living species as to permit their inclusion in living families.

In 1935 Miller and Thompson (6) discussed the significance of *Aturoidea* in the Hornerstown, Vincentown and Manasquan formations of New Jersey as follows:

> Although representatives of the genus *Aturoidea* have been found in beds which are clearly Upper Cretaceous in age, the Upper Cretaceous and the so-called Danian forms from India and northern Africa are very much more primitive than are the definitely Eocene forms, *A. parkinsoni* and *A. spathi*. As can be seen by comparing the figures on plates 65 and 66, *A. paucifex* and *A. pilsbryi* are strikingly similar to *A. parkinsoni* of the London clay (Yprésien), which has been correlated by some authors with the Aquia formation of Maryland and the upper portion of the Wilcox group of the Gulf Coastal Plain. *Aturoidea spathi* of the Eocene Ranikot series of India also appears to be very closely related, and although these four species came from three widely separated localities, the fact that they are very closely similar indicates that the beds which yielded them are probably not greatly different in age.

Jennings' (7) conclusions (1936), based on the microfauna of the Monmouth group and of the Hornerstown marl of the Rancocas group, add confirmatory evidence of the Eocene age of the Hornerstown.

Kummelia Stephenson, n. gen.

Type species: *Gastrochaena americana* Gabb.

The proposed new genus *Kummelia* is a sand-boring pelecypod that secreted an inclosing, long, tapering, more or less irregular tube characterized

by rather widely spaced annular grooves of somewhat irregular trend around the tube. The spacing of the grooves ranges from 2 to 7 millimeters, and the angle of divergence of opposite sides of the tube is approximately 6 degrees. The small end of the tube is not complete in any of the available material. The large end of the tube is sealed over in adults. The shell found within the tube is elongated, subtrigonal in outline, and is widely gaping posteriorly, ventrally and anteriorly. In form it closely resembles the shell of the Recent genus *Roscellaria* Blainville, whose tube in contrast is short, irregular, roughly bottle- or jug-shaped, and is rendered even rougher in appearance by the adherence to its outer surface of sand grains, fragments of shells, and other extraneous matter.

In its habit of growth this bivalve began at a young stage to bore in the sand and to construct a protecting tube of calcium carbonate around itself. As it bored deeper and grew larger it gradually increased the size of its tube and eventually reached a size such that it could not escape backward out of its self-constructed prison; however, it maintained connection with the outer world, that is with the water above the small end of the tube, by means of an elongated siphon. As shown by the position of the shell in the large incomplete tube illustrated in Figures 6–8, the animal was able to back up a distance of at least 34 millimeters from the basal, or large end. In other tubes the shell is at the base. In all cases observed the forward end of the shell is directed toward the large end of the tube.

For further details see the following description of the type species, *Kummelia americana* (Gabb).

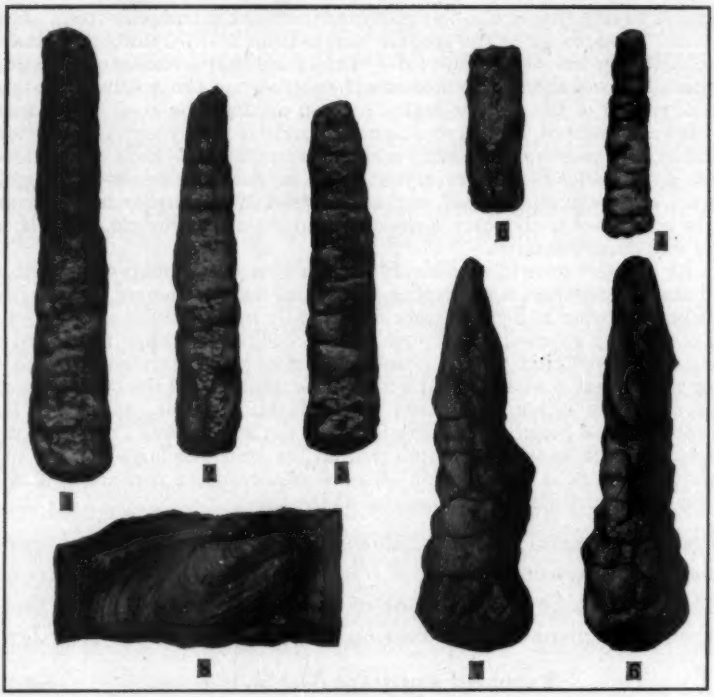
The genus is named in honor of Dr. Henry B. Kummel, Director of the Department of Conservation and Development of New Jersey.

Kummelia americana (Gabb), n. comb. Figs. 1–8

1860. *Gastrochaena americana* Gabb, Acad. Nat. Sci. Philadelphia, Jour., 2d ser., vol. 4, p. 393, pl. 68, fig. 20.
1861. *Polorthus americana* Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 13, p. 367. (In part.)
1872. *Polorthus americanus* Gabb, Acad. Nat. Sci. Philadelphia Proc., vol. 24, p. 259, pl. 8, fig. 8. (In part.)
1885. *Gastrochaena americana* Gabb. Whitfield, U. S. Geol. Survey Mon., vol. 9, p. 203, pl. 26, figs. 17, 18 (in part). (New Jersey Geol. Survey, Paleontology, vol. 1, p. 203, pl. 26, figs. 17, 18, 1886.)
1905. *Gastrochaena americana* Gabb. Johnson, Acad. Nat. Sci. Philadelphia Proc., vol. 57, p. 18.
1907. *Gastrochaena americana* Gabb. Weller, Geol. Survey New Jersey, Paleontology, vol. 4, p. 649, pl. 73, fig. 13.

The following is Gabb's original brief description of the tube of this species: "Elongated conical; transversely wrinkled; termination of widest end, round. Length 2.5 in., greatest diameter 0.5 in. Common in the yellow limestone [Vincentown] of Timber Creek, and found with the above species [*Teredo irregularis*] in the brown marl [Hornerstown] of Burlington Co., N. J."

In the collection of the Academy of Natural Sciences of Philadelphia is a tray containing 8 incomplete internal molds of tubes apparently representing as many individuals, labeled *Gastrochaena americana* Gabb (A.N.S.



Figs. 1–8.—*Kummelia americana* (Gabb). 1, a tube, the largest among the 8 cotypes (A.N.S.P. no. 13403); this is probably the specimen which served as the principal basis for Gabb's original drawing, which, however, appears to have been partly restored at the small end on the basis of the smallest cotype. 2, one of the cotypes (A.N.S.P. no. 13403), a tube with impressions of the two valves of the shell, uncovered at the large end. 3, 4, tubes from the Vincentown sand of New Jersey (U.S.G.S. Coll. 17282), showing the characteristic annulations (U.S.N.M. 496382). 5, a tube in the same lot as the preceding, showing impressions of the two valves of the shell, uncovered at the large end. 6, 7, an incomplete tube and shell from the Aquia formation ¾ mile west of Oak Grove, Prince Georges County, Md. (U.S.G.S. Coll. 16014); just prior to the animal's death it had backed up a distance of 34 mm from the large end of the tube (U.S.N.M. 496381). 8, an enlarged view of the shell, a right valve, in the tube shown in the two preceding figures.

No. 13403). I am indebted to Dr. Henry A. Pilsbry for the privilege of examining and redescribing Gabb's types. The largest of the specimens, marked "type" in faded ink, is 69 mm long, 12.5 mm in greatest diameter, and 7 mm in least diameter (Fig. 1); this tube is shorter than the original figure, which is 76 mm long, but is longer than the dimensions (2.5 inches) given by Gabb. The small end appears to be freshly broken and the tube may have met with an accident subsequent to the drawing of the original figure, which appears to represent a tube more symmetrical and smoother than the supposed type; however, the drawing may have been somewhat generalized. A small label in the tray in Gabb's handwriting reads: "*Gastro-*

chaena americana Gabb, Timber Creek, N. J. Types." The word *Gastrochaena* has been crossed out in pencil and the word *Polorthus* written below it, apparently in the same handwriting. All the specimens have the characteristic annular rings more or less clearly impressed upon them. The large end of the tube marked "type" bears indistinct markings which appear to pertain to the forward end of the inclosed shell. On the large end of another specimen in the lot the forward end of the shell was unmistakably exposed and was subsequently uncovered by the present author (Fig. 2); it is rather poorly preserved. These evidences of the presence of shells within the tubes were not recorded by either Gabb or Whitfield.

The following description is based on the type material, supplemented by 7 specimens in the U. S. National Museum labeled "Vincentown sand" (without further locality description), one specimen collected by the writer from the Vincentown sand on Crosswicks Creek, N. J., and one specimen from the Aquia formation near Oak Grove, Md.; the shell is best preserved on the last mentioned specimen.

Tube long, slender, tapering, circular in cross section, with sides diverging downward at an angle of approximately 6 degrees. The tubes vary from nearly straight to slightly and irregularly sinuous, and are marked by a series of transverse, irregularly spaced, suture-like grooves, at vertical intervals of 2 to 7 mm; the outer surface is more or less rough and irregular. The tubes have a maximum measured diameter of 18 mm and an undetermined minimum diameter of less than 4 mm. Complete adult tubes may have exceeded a length of 120 mm. The large end of the tube of adults is sealed over with a layer of calcium carbonate; it is broadly rounded, becoming more sharply rounded on its perimeter. On corroded specimens the grooves are seen to mark the edges of transverse septum-like walls similar to the convex calcitic layer sealing the large end of the tube; these walls may have sealed the tube at the successive growth stages indicated by the grooves, and were centrally resorbed or mechanically removed sufficiently to permit the animal to advance during each new growth stage.

In the incompletely labeled lot in the National Museum the large end of a small tube contains the impression of a bivalve shell with both valves intact in a fair state of preservation (Fig. 5), and a better preserved shell is contained in the tube from near Oak Grove, Md. (Figs. 6–8). The shell is elongated subtrigonal in outline; although the valves appear to be partly spread apart ventrally, the shell was obviously widely gaping posteriorly, ventrally and anteriorly. The beaks are situated about 1.5 mm back of the sharply rounded anterior extremity; they are small, incurved, and prosogyrate. The umbonal region is broad and only moderately prominent, descending steeply in front; it forms a broadly rounded inflation which extends backward and slightly downward, broadening and fading out toward the lower posterior extremity.

Hinge line long and straight, antero-dorsal margin short, slightly descending; anterior margin sharply rounded above, curving less sharply into the long, broadly rounded, slightly sinuous ventral margin; posterior margin sharply rounded below, curving broadly into the dorsal margin above. The dorsal margins of the two valves found form a keel of moderate prominence toward the posterior end of the hinge. Hinge and interior features not uncovered. Surface of shell marked by irregularly developed, low, moderately coarse, concentric wrinkles which are strongest anteriorly below the umbonal inflation.

The incomplete tube from near Oak Grove, Md., is larger than any of

the available New Jersey specimens. It measures: Length 61+ mm, maximum diameter at the large end 18 mm. The right valve of the shell in this tube has been uncovered in a fair state of preservation; at the time of the animal's death it had backed up until the front end of its shell was 34 mm above the large end of the tube. The shell is 17 mm long and 9 mm high. The tube exhibits the same sort of irregular annulations as those on the tubes from the Vincentown sand; although the Maryland specimen is incomplete and imperfectly preserved, both the tube and shell characters are essentially like those of the New Jersey specimens, and there is no reasonable doubt of their specific identity.

The shell of *Kummelia americana* lacks the square anterior truncation of *Gastrochaena* and has a broadly rounded ventral margin instead of a nearly straight one. The tubes of the two genera are also markedly different. *Gastrochaena* has a straight, regularly tapering tube marked by numerous closely-spaced, regular annulations; the tube of *Kummelia* has a rougher exterior, is more or less sinuous, and is characterized by much wider annulations separated by grooves of irregular spacing, which pass around the tube in an irregularly sinuous trend. The genotype of *Gastrochaena* is *G. mumia* Spengler, a Recent species.

The known material of *K. americana* includes the following:

A.N.S.P. no. 13403 (types). Vincentown sand on Timber Creek, N. J.; this creek forms the boundary between Camden and Gloucester Counties.

U.S.N.M. 496380 (U.S.G.S. Coll. 17279). Vincentown sand on a small east-flowing branch of Crosswicks Creek 0.7 mile north by west of New Egypt, Ocean County, N. J.; fragment of the large end of a tube 33 mm long, from within 10 feet of the base of the formation. Collected by the author, October 10, 1936.

U.S.N.M. 496382 (U.S.G.S. Coll. 17282). Three figured specimens labeled "Vincentown sand," with no additional information as to locality; the material doubtless came from New Jersey. U.S.N.M. 496383 (U.S.G.S. Coll. 17282). Four unfigured specimens from the preceding lot.

U.S.N.M. 496381 (U.S.G.S. Coll. 16014). Aquia formation in a road cut on the west-facing slope of the valley of the West Branch of Patuxent River, 3/4 mile west of Oak Grove, 2.6 miles west of Leeland, Prince Georges County, Md. Collected by J. B. Reeside, Jr., 1931.

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ENTOMOLOGY.—*The bees of the genera* Augochlora, Augochloropsis, *and* Augochlorella (*Hymenoptera; Apoidea*) *occurring in the United States.*[1] GRACE A. SANDHOUSE, Bureau of Entomology and Plant Quarantine. (Communicated by C. F. W. MUESEBECK.)

This study of the brilliant, blue-green halictine bees of the genera *Augochlora*, *Augochloropsis*, and *Augochlorella* occurring in the United States was undertaken to facilitate their identification. The collections representing these genera in the United States National Museum have served as a basis for this revision and were supplemented by loans from other institutions and private collections.

I am greatly indebted to Mr. Robert B. Benson, of the British Museum, for comparison of specimens with the types of Smith's species; to Dr. C. R. Jones for information about the types in the collection of the Colorado Agricultural College; and to Messrs. Pierre-Georges Roy and Noel Comeau of the Musée de la Province de Quebec for comparisons of material with Provancher's types.

These genera may be separated by the following key:

1. First and second abdominal tergites each with apical fringe of simple bristles (if the fringe is worn off, an apical row of punctures visible); pubescence of tergites uniform and directed posteriorly; tegula large, metallic blue-green, caudal margin nearly truncate, inner margin emarginate; carinae on posterior-lateral angles of propodeum parallel, extending almost to dorsal surface. Female: Apical portion of labrum semicircular; posterior calcar of hind tibia pectinate. Male: Labrum with a median basal groove; first three abdominal segments more strongly developed than the others, the caudal segments usually partially retracted within the third; fourth sternite concealed under third, posterior-lateral angles extending into long processes, caudal margin with median projection, margin of fifth emarginate..... *Augochloropsis* Cockerell

   First and second abdominal tergites each without apical fringe of simple bristles, apical margins impunctate; tergites with long hairs directed posteriorly and short hairs laterally; tegula small, oval, brown or testaceous, usually without metallic tints; carinae on posterior-lateral angles of propodeum converging below, extending less than half way to dorsal surface. Female: Apical portion of labrum narrowly triangular; posterior calcar of hind tibia serrulate. Male: Labrum without a median basal groove; abdominal segments more uniformly developed, caudal segments not retracted; fourth sternite without posterior-lateral processes, caudal margin truncate or emarginate, margin of fifth usually truncate..... 2

2. Head broad, ocellocular line one and one-half times as long as postocellar; vertex gradually declivous behind postocellar line to the sharply defined occipital carina, the carina extending to hypostomal carinae;

[1] Received December 28, 1936.

mesopleura punctate; metapleural suture carinate; apex of radial cell truncate, with appendiculate vein. Female: Mandible apically bidentate, the teeth subequal; first sternite usually with median carina or tooth, sixth with median triangular polished area; inner surface of hind femur with single row of long pinnately branched hairs. Male: Second flagellar joint distinctly longer than first; sides of propodeum deeply, nearly contiguously punctured; caudal margin of fourth sternite truncate ..... *Augochlora* Smith

Head narrow, ocellocular line subequal to postocellar; vertex abruptly declivous behind postocellar line to the more weakly defined occipital carina, the carina obsolescent some distance from hypostomal carinae; mesopleura irregularly foveolate, indistinctly punctured; metapleural suture not carinate; apex of radial cell pointed. Female: Mandible with large rounded inferior tooth and smaller superior tooth separated by narrow emargination; first sternite without carina or tooth, sixth without triangular polished area; inner surface of hind femur with several rows of short unilaterally branched hairs. Male: First and second flagellar joints subequal; sides of propodeum indistinctly and rather sparsely punctured; caudal margin of fourth sternite usually emarginate ..... *Augochlorella*, n. gen.

Augochlorella, n. gen.

Augochlora F. Smith, Cat. Hym. Brit. Mus., **1**: 73. 1853 (part).—Provancher, Natur. Canad., **13**: 205. 1882 (part).—Petit, Faun. Ent. Canad., p. 705, 1883 (part).—Robertson, Trans. Amer. Ent. Soc., **20**: 147. 1893 (part).—Dalla Torre, Cat. Hym., **10**: 93. 1896 (part).—Cockerell, Canad. Ent., **29**: 4. 1897 (part).—Robertson, Canad. Ent., **29**: 64. 1897 (part).—Cockerell, Trans. Amer. Ent. Soc., **24**: 162. 1897 (part).—Ashmead, Trans. Amer. Ent. Soc., **26**: 91. 1899 (part).—Cockerell, Proc. Acad. Nat. Sci. Phila., p. 374, 1900 (part).—Trans. Amer. Ent. Soc., **31**: 356. 1905 (part) (new synonymy).

Oxystoglossa Robertson, Canad. Ent., **34**: 244. 1902 (part) (new synonymy).

Halicti falcati groupe *Oxystoglossa* Vachal, Misc. Ent., **19**: 14. 1911 (part).

Genotype: Augochlora gratiosa Smith.

This genus is similar in general appearance and color to *Augochlora*, and the species assigned here were previously placed in that genus. The characters of the genus follow:

Head: In facial view nearly triangular, with angles rounded. Eyes large and bare, with their inner margins weakly emarginate, forming the lateral boundaries of the head for most of its length. Front slightly convex, contiguously punctured, occupying about half the space between anterior ocellus and apex of clypeus; a fine median carina on lower half. Vertex sparsely punctured, rather abruptly declivous to occipital carina. Postocellar line subequal to ocellocular. Occipital carina moderately well developed, obsolescent some distance from hypostomal carinae. Clypeus as broad as long in female, narrower in male, extending about half its length beyond lower margin of eye, apical margin truncate; clypeus and postclypeus strongly convex, with large punctures separated by more than their diameter; postclypeus shorter than clypeus. Basal portion of labrum of female broadly subrectangular, medially tumescent, apical portion narrowly triangular, medially sharply carinate, margins fringed with simple bristles. Labrum of male broadly subrectangular, convex, apical margin slightly curved and fringed, the bristles shorter than in the female. Gena obsolete.

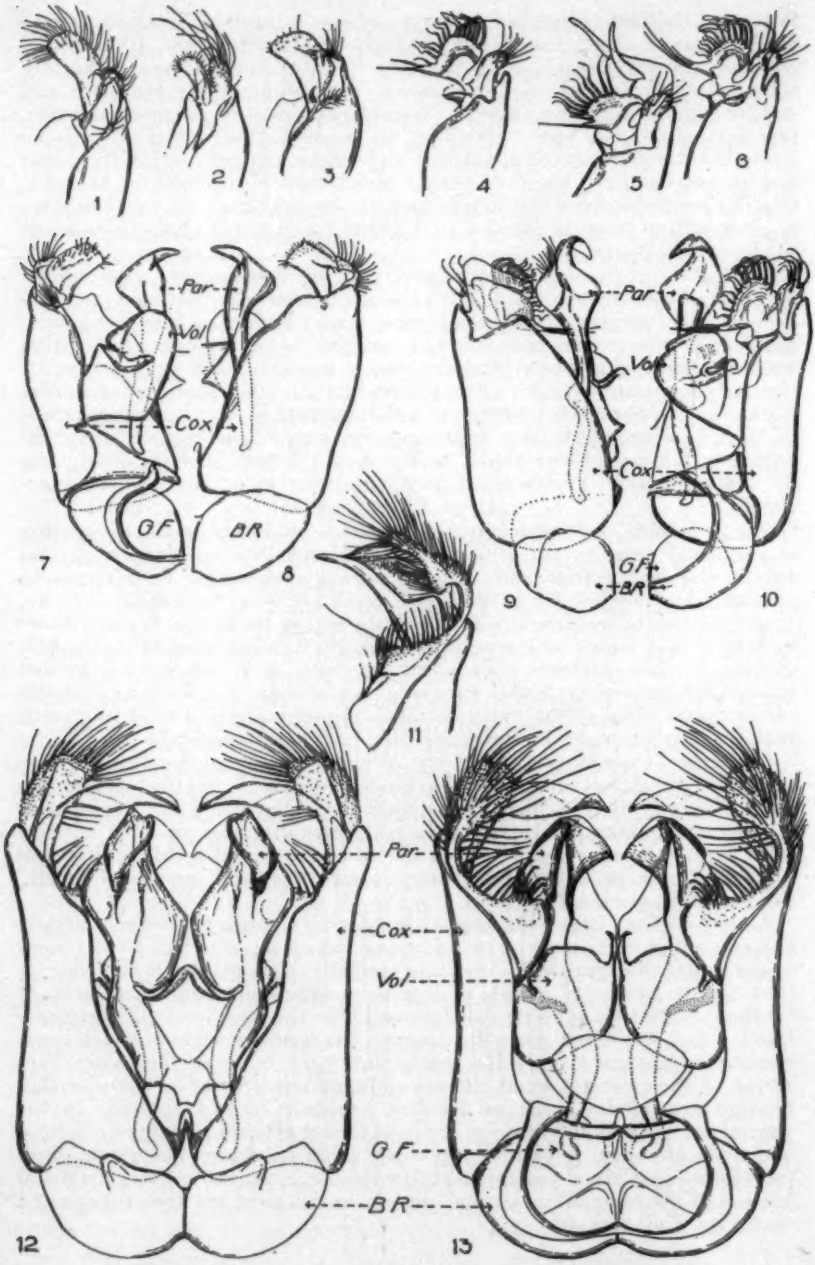
Post-gena declivous from outer margin of eye to occipital carina, striato-punctate above, finely tessellate and nearly impunctate below. Hypostomal carinae well developed, nearly parallel, without modifications. Mandible rather strongly curved; of female, with large rounded inferior tooth and smaller superior tooth separated by narrow emargination; of male edentate, tapering to pointed apex. Maxillary palpi six-jointed, labial palpi four-jointed. Antennae inserted about half way between apical margin of clypeus and postocellar line; scape of female about one-third length of antenna, flagellar joints progressively longer to apex; scape of male subequal to combined length of flagellar joints 4 to 6, joints 3 and 4 subequal, distal joints progressively longer.

General structure of thorax similar to that of related genera, more robust in female. Pronotum not modified. Mesoscutum broader than long, punctation usually varying specifically; parapsidal furrows as long as tegula, parallel; mesoscutellum nearly twice as long as metanotum, punctation similar to that of scutum. Mesopleuron, metanotum, and metapleuron irregularly foveolate-punctate. Propodeum extending horizontally for a short distance, then abruptly declivous to attachment of abdomen; dorsal surface or "disk" subcrescentic, the sculpture varying specifically; posterior-lateral angles carinate on lower third; posterior and lateral surfaces irregularly foveolate-punctate. Tegula small, oval, anteriorly with fine setiferous punctures.

Wings hyaline, yellowish infumate, veins brownish testaceous; venation of the usual type for the Halictinae; radial cell pointed at apex; second cubital cell higher than wide, always narrower in males. First recurrent nervure antefurcal or interstitial with second transverse cubital nervure. Legs typical for the subfamily and constant within the genus. Female: Inner surface of hind femur with several rows of short, unilaterally branched hair (similar to *Augochloropsis*); outer surface with long, pinnately branched hairs; knee-plate of hind tibia subovate, not so sharply defined as in *Augochlora;* inner tibial calcar serrulate. Male: Inner margin of hind basitarsus with fringe of hairs, which sometimes vary in length specifically.

Abdomen of female broadly ovate, of male more slender; tergites rather uniformly punctured except that the caudal margins are impunctate; shorter hairs directed laterally, longer ones posteriorly. Female: Fifth tergite with median rima, laterally densely pubescent; pygidial area of sixth narrow, sides parallel, apex truncate, apical-lateral angles rounded. Male: Sternites unmodified except the median emargination of caudal margin of fourth, which varies specifically.

Male genitalia: Basal ring cupuliform dorsally, much narrower ventrally and extending posteriorly as two processes which are attached to the bases of the coxopodites, instead of meeting medially. Coxopodites broad, shorter than the parameres, the distal ends with modifications which are constant for the species. On the ventral surface and near the distal end of the coxopodite is a flat, somewhat plate-like process, the caudal margin of which bears ribbon-like processes. Volsellae nearly flat, lying between the coxopodites distad of their ventral basal processes. Parameres narrow at bases, rather broadly expanded just before bending ventrally, apices pointed; on the ventral surface and just basad of the expanded portion is a slender projection with truncate apex. A figure of the entire genitalia of only one species (*gratiosa* (Smith)) is given and for the other species, a ventral view of the distal portion of the coxopodite, as that portion varies most between the species. (See Figs. 4, 5, 6, 9, 10.)



For explanation of Figs. 1–13, see bottom of opposite page.

Species brilliant blue-green, with sternites and legs largely brown; tarsi of male sometimes paler. Pubescence inconspicuous, white or yellowish.

KEY TO SPECIES OF THE UNITED STATES

1. Disk of propodeum carinate to caudal margin, median apical portion slightly depressed, median length subequal to that of metanotum, or slightly less, carinae longitudinal, radiating slightly. Mesoscutum anteriorly and laterally rugose-punctate.....2

Disk of propodeum not carinate to caudal margin, median apical portion not depressed, median length always distinctly greater than that of metanotum, carinae very irregular. Mesoscutum closely and uniformly punctured.....3

2. Disk of propodeum with many fine, slightly irregular carinae. Male: Hairs at base of hind basitarsus distinctly more than half its length; caudal margin of fourth sternite with deep median emargination.....*gratiosa* (Smith)

Disk of propodeum with few coarse, regular carinae. Male: Hairs at base of hind basitarsus distinctly less than half its length; caudal margin of fourth sternite with shallow median emargination.....*striata* (Provancher)

3. Tegula testaceous; caudal portion of disk of propodeum polished; caudal margins of abdominal tergites testaceous; species 5.5 to 6 mm long. Male: Caudal margin of fourth sternite with rather shallow median emargination; flagellum and tarsi testaceous; second flagellar joint hardly longer than first, shorter than third.....*aurata* (Smith)

Tegula dark brown; caudal portion of disk of propodeum dull, microscopically tessellate; caudal margins of abdominal tergites narrowly margined with black; species 9 to 10 mm long. Male: Caudal margin of fourth sternite subtruncate; flagellum and tarsi dark brown; second flagellar joint distinctly longer than first, subequal to third.....*pomoniella* (Cockerell)

Augochlorella gratiosa (Smith), n. comb.

Augochlora gratiosa F. Smith, Cat. Hym. Brit. Mus., 1: 80. 1853.—Dalla Torre, Cat. Hym., 10: 95. 1896.

Augochlora austrina Robertson, Trans. Amer. Ent. Soc., 20: 147. 1893.—Dalla Torre, Cat. Hym., 10: 94. 1896 (new synonymy).

Fig. 1.—*Augochlora nigrocyanea* Cockerell. Distal portion of coxopodite, ventral view. Fig. 2.—*A. aztecula* Cockerell. Distal portion of coxopodite, ventral view. Fig. 3.—*A. transversalis* Sandhouse and Cockerell. Distal portion of coxopodite, ventral view. Fig. 4.—*Augochlorella striata* (Provancher). Distal portion of coxopodite, ventral view. Fig. 5.—*A. pomoniella* (Cockerell). Distal portion of coxopodite, ventral view. Fig. 6.—*A. aurata* (Smith). Distal portion of coxopodite, ventral view. Fig. 7.—*Augochlora pura* (Say). Male genitalia, ventral view of right half. Fig. 8.—*A. pura*. Male genitalia, dorsal view of right half. Fig. 9.—*Augochlorella gratiosa* (Smith). Male genitalia, dorsal view of left half. Fig. 10.—*A. gratiosa*. Male genitalia, ventral view of left half. Fig. 11.—*Augochloropsis cuprea* (Smith). Distal portion of coxopodite, ventral view. Fig. 12.—*A. caerulea* (Ashmead). Male genitalia, dorsal view. Fig. 13.—*A. caerulea*. Male genitalia, ventral view.

BR, Basal Ring; *GF*, Genital Foramen; *Cox.*, Coxopodite; *Vol.*, Volsella; *Par.*, Paramere. The illustrations were made by Mrs. Eleanor A. Carlin of the Bureau of Entomology and Plant Quarantine.

Augochlora festiva Graenicher (not Smith), Ann. Ent. Soc. Amer., **23**: 157. 1930 [erroneous determination].

Type: Female, from Georgia, in the British Museum, where it was compared with material submitted by the writer. The type of *austrina* is in Robertson's collection. The species can be distinguished by the characters of the disk of the propodeum and the hairs on the basitarsus of the male.

Distribution: Apparently limited to the southeastern part of the United States. Specimens have been seen from the following States: New Jersey, North Carolina, South Carolina, Georgia, Florida, and Alabama.

Augochlorella striata (Provancher), n. comb.

Augochlora striata Provancher, Addit. Faun. Canad. Hym., p. 317, 1888.—Dalla Torre, Cat. Hym., **10**: 96. 1896.

Augochlora pura Robertson (not Say), Trans. Amer. Ent. Soc., **20**: 146. 1893 [erroneous determination].

Augochlora matilda Robertson, Trans. Amer. Ent. Soc., **20**: 147. 1893.—Dalla Torre, Cat. Hym. **10**: 95. 1896 (new synonymy).

Augochlora confusa Robertson, Trans. Acad. Sci. St. Louis, **7**: 324. 1897 (new synonymy).

Oxystoglossa confusa (Robertson), Canad. Ent., **34**: 247. 1902.

Augochlora (*Augochlora*) *coloradensis* Titus, Canad. Ent., **33**: 133. 1901 (new synonymy).

Augochlora confusa coloradensis Cockerell, Ann. Mag. Nat. Hist., (7), **12**: 442. 1903.

Halictus asaphes Vachal, Misc. Ent., **19**: 49. 1911 (new synonymy).

Halictus (*Oxystoglossa*) *purus* Vachal, Misc. Ent., **19**: 50, 53, 111. 1911 (new synonymy).

Augochlora pseudopurella Strand, Archiv. Naturg., Abt. A., **80**: 163. 1914. (Proposed for *Halictus purus* Vachal, not Say) (new synonymy).

Halictus (*Oxystoglossa*) *confusus* Viereck, Conn. Geol. & Nat. Hist. Surv., **22**: 705. 1916.

Augochlora coloradensis Hicks, Canad. Ent., **63**: 176. 1931.

Types: Female and male, from Quebec, Canada, in the Musée de la Province de Quebec, where through the courtesy of M. Roy they were compared with material submitted by the writer. The types of *confusa* and *matilda* are in Robertson's collection. The type of *coloradensis* is in the collection of the Colorado Agricultural College. The female is sometimes rather difficult to separate from that of *gratiosa*, as the regularity of the carinae on the disk of the propodeum varies somewhat, but these are always much coarser in *striata;* the males are readily separated by the characters of the hind basitarsus and fourth sternite.

Distribution: United States east of the Rocky Mountains, from Maine to Florida and from South Dakota to New Mexico. Specimens have been seen from the following States: Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, South Dakota, Nebraska, Kansas, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas, Colorado, and New Mexico. The species is also known to occur in Ontario and Quebec, Canada.

Augochlorella aurata (Smith), n. comb.

Augochlora aurata F. Smith, Cat. Hym. Brit. Mus., **1**: 82. 1853.—Dalla Torre, Cat. Hym., **10**: 94. 1896.

Augochlora similis Robertson, Trans. Amer. Ent. Soc., **20**: 146. 1893.—Dalla Torre, Cat. Hym., **10**: 96. 1896 (new synonymy).

Augochlora confusa Cockerell (not Robertson), Bull. New Mex. Expt. Sta., **24**: 25. 1897 [erroneous determination].

Augochlora neglectula Cockerell, Bull. New Mex. Exp. Sta., **24**: 43. 1897 (new synonymy).

Oxystoglossa similis (Robertson), Canad. Ent., **34**: 247. 1902.

Halictus (*Augochlora*) *auratus* Viereck, Rept. New Jersey State Mus., p. 688, 1910.

Halictus (*Oxystoglossa*) *persimilis* Viereck, Rept. New Jersey State Mus., p. 688, 1910. (Proposed for *Halictus similis* (Robertson), not Smith) (new synonymy).

?*Halictus* (*Oxystoglossa*) *xystris* Vachal, Misc. Ent., **19**: 50. 1911 (new synonymy).

Type: Female, from St. John's Bluff, eastern Florida, in the British Museum, where it was compared with material submitted by the writer. The type of *similis* is in Robertson's collection. The type of *neglectula* is in Cockerell's collection; a "cotype" (paratype) is in the U. S. National Museum. The present location of the type of *xystris* is unknown to the writer. This species differs from *pomoniella* in size, color of tegulae and caudal margins of abdominal tergites, and sculpture of disk of propodeum.

Distribution: Apparently limited to the United States east of Rocky Mountains and south of the forty-second degree of latitude. Specimens have been seen from the following States: Maryland, Virginia, District of Columbia, North Carolina, Georgia, Florida, Indiana, Illinois, Minnesota, Iowa, Missouri, Kansas, Arkansas, Louisiana, Oklahoma, Texas, Colorado, and New Mexico.

Augochlorella pomoniella (Cockerell), n. comb.

Augochlora pomoniella Cockerell, Pomona Jour. Ent. & Zool., **7**: 232. 1915.—Pan-Pac. Ent., **3**: 162. 1927.

Type: Female, from Aliso Canyon, California, is in the U. S. National Museum. Of the species included in this genus, *pomoniella* approaches most nearly to *Augochlora* by the slightly wider head, dark caudal margins of the abdominal tergites, and shape of the fourth sternite of the male. It can be separated from *aurata* by the characters mentioned under that species.

Distribution: Apparently limited to the extreme southwestern part of the United States. Specimens have been seen from the following States: Arizona, Utah (southwestern part), and California (southern half).

Augochloropsis Cockerell

Augochlora (*Augochloropsis*) Cockerell, Canad. Ent., **29**: 4. 1897.—Proc. Acad. Nat. Sci. Phila., p. 374, 1900. *Genotype:* (*Augochloropsis subignita* Cockerell) = *Augochloropsis ignita* (Smith) (original designation).

Augochlora F. Smith, Cat. Hym. Brit. Mus., **1**: 73; pl. 3, fig. 10, 1853 (part).—Robertson, Trans. Amer. Ent. Soc., **20**: 147. 1893 (part).—Dalla Torre, Cat. Hym., **19**: 93. 1896 (part).—Robertson, Canad. Ent., **29**: 64. 1897 (part).—Cockerell, Trans. Amer. Ent. Soc., **24**: 162. 1897

(part).—Robertson, Canad. Ent., **29**: 176. 1897 (part).—Ashmead, Trans. Amer. Ent. Soc., **26**: 91. 1899 (part).—Robertson, Canad. Ent., **34**: 245. 1902.—Cockerell, Trans. Amer. Ent. Soc., **31**: 356. 1905 (part).

Halicti vibrissati groupe *Augochlora* Vachal, Misc. Ent., **11**: 126. 1903.—Misc. Ent., **19**: 13. 1911.

Augochloropsis (*Paraugochloropsis*) Schrottky. Zeit. Syst. Hym. Dipt., **6**: 312. 1906. *Genotype: Augochloropsis* (*Paraugochloropsis*) *lycorias* Schrottky (monobasic).

Tetrachlora Schrottky, Deut. Ent. Zeit., p. 481, 1909. *Genotype: Augochlora* (*Tetrachlora*) *multiplex* Vachal (monobasic).

Augochoropsis Schrottky, Deut. Ent. Zeit., p. 540, 1910.

This genus can be separated from the other genera of the Halictinae in the Nearctic fauna by the fringes of hair on the caudal margins of the first and second abdominal tergites (not to be confused with the preapical fasciae in *Halictus* s. str.) and by the large tegulae with truncate caudal margins. In general structure similar to *Augochlorella*, but differing in that the inner margins of the eyes are more deeply emarginate; labrum of female with basal portion broad, medially with longitudinal furrow, apical portion subsemicircular with high median carina, labrum of male with median furrow on basal portion; scape of male subequal to combined length of flagellar joints 3 to 6, fourth as wide as long, distal joints a little longer than wide. Pronotum laterally laminately produced, varying specifically. Posterior-lateral angles or propodeum with carinae extending nearly to caudal margin of disk. Female with knee-plate of hind tibia obsolete, inner calcar pectinate. Pubescence of abdominal tergites uniform and directed posteriorly; caudal margins of first and second tergites each with a single row of punctures and a fringe of coarse simple bristles; caudal segments of male usually retracted; posterior-lateral angles of fourth sternite produced into long processes.

Male genitalia: In general structure similar to those of *Augochlorella* but differing as follows: Volsella with slender process on inner caudal angle. Coxopodites longer than parameres, distal ends tapering and strongly convergent, ventral surface without a plate-like process. Apices of parameres broader. An illustration of the entire genitalia is given for *A. caerulea* (Ashm.), but for the others only a ventral view of the distal portion of the coxopodite, as that portion varies the most between the species. (See Figs. 11, 12, 13.)

Only two species are known to occur in the United States. They may be separated as follows:

Humeral angles of pronotum prominently developed, especially anteriorly; thoracic and abdominal tergites dull and microscopically tessellate between punctures; punctures on pleura and sides of propodeum contiguous; disk of propodeum dull, with fine irregular carinae; vertex elevated behind ocelli; postocellar line less than ocellocular; species usually 12 to 13 mm long; wings strongly infumated. Male: Fourth sternite with median caudal projection apically truncate, caudal margin of third truncate, of fifth with shallow emargination; tarsi dark brown ..... *caerulea* (Ashmead)

Humeral angles of pronotum less prominently developed; thoracic and abdominal tergites shining between punctures; punctures on pleura and sides of propodeum separated by at least the diameter of a puncture; disk of propodeum shining, without carinae; vertex not elevated behind ocelli; postocellar line greater than ocellocular; species usually about 10 mm long; wings slightly infumated, yellowish. Male: Fourth sternite

with median projection apically pointed, caudal margin of third broadly convex, of fifth with broad deep emargination; tarsi yellow.....
.....*cuprea* (Smith)

Augochloropsis ignita (Smith), n. comb.

Augochlora ignita F. Smith, Jour. Entom., **1**: 147. 1861.—Dall Torre, Cat. Hym., **10**: 95. 1896.

Augochlora subignita Cockerell, Trans. Amer. Ent. Soc., **24**: 145. 1897 (new synonymy).

Augochlora (*Augochloropsis*) *subignita* Cockerell, Canad. Ent., **29**: 145. 1897.

?*Augochlora fulvfimbriata* Friese, Stett. Ent. Zeit., **77**: 315. 1916, male only (new synonymy).

Type: Female, from Mexico, in the British Museum, where it was compared with specimens submitted by the writer. The type of *subignita* is in the Academy of Natural Sciences of Philadelphia; a paratype, in the U. S. National Museum. This synonymy is based on a study of material compared with the type of *ignita* and a part of the type series of *subignita*. The synonymy of *fulvofimbriata* which is tentatively suggested is based upon the study of a male specimen identified by Friese. Reference to *ignita*, which does not occur in the United States, is included only to give the synonymy of the genotype.

Augochloropsis caerulea (Ashmead)

Augochlora humeralis Patton, Bull. U. S. Geol. & Geogr. Surv., **5**: 365. 1879. —Dalla Torre, Cat. Hym., **10**: 95. 1896.—J. B. Smith, Jour. New York Ent. Soc., **9**: 52–72; text-figs. 1–3, pls. 3–5, 1901 (new synonymy).

Agapostemon caeruleus Ashmead, Bull. Colo. Biol. Assoc., **1**: 7. 1890.—Dalla Torre, Cat. Hym., **10**: 97. 1896.

Augochlora (*Augochloropsis*) *humeralis* Cockerell, Canad. Ent., **29**: 5. 1897.

Augochlora (*Augochloropsis*) *caerulea* Titus, Canad. Ent., **33**: 136. 1901.

Augochlora caerulea Crawford, Proc. Nebr. Acad. Sci., **7**: 165. 1901.

Halictus (*Augochlora*) *pattoni* Vachal, Misc. Ent., **11**: 132. 1903; **12**: 12. 1904. (Proposed for *Halictus* (*Augochlora*) *humeralis* Patton, not *Halictus humeralis* Sichel) (new synonymy).

Augochlora sumptuosa bolliana Cockerell, Ann. Mag. Nat. Hist., (8), **4**: 31. 1909 (new synonymy).

Halictus (*Augochlora*) *humeralis* Viereck, Rept. New Jersey State Museum, p. 688. 1901.

Augochlora lacustris Cockerell, Proc. U. S. N. M., **60** (18): 14. 1922 (new synonymy).

Augochlora floridica Cockerell, idem, 1922 (new synonymy).

Augochlora fulgida Graenicher, (not Smith), Ann. Ent. Soc. Amer., **23**: 157, 167. 1930 [erroneous determination].

Type: Male [not a female, as designated in the original description], labeled "Col." [although the type locality is cited as Denver, Colorado], in the U. S. National Museum. The types of *humeralis* are in the Academy of Natural Sciences of Philadelphia, where they were seen by the writer. The types of *sumptuosa bolliana*, *lacustris*, and *floridica* are in the U. S. National Museum, where they have been compared with *caerulea* and found to be identical. The name *humeralis* is a secondary homonym only in *Halictus*, but it has seemed best to follow the International Rules strictly in this matter. This species varies considerably in color, but is usually more bluish than *cuprea;* specimens from Florida are frequently deep purplish blue, as are also

representatives of other species. In an account of the nesting habits (J. B. Smith, 1901) it is said to make deep and complicated burrows in the ground. It may be readily distinguished from *cuprea* by the characters given in the key, particularly the angles of the pronotum, the more strongly elevated vertex, and the brown tarsi of the male.

Distribution: Apparently limited to the southeastern and central parts of the United States, extending from New Jersey south to the tip of Florida and west to South Dakota and Texas. Specimens have been seen from the following States: New Jersey, Virginia, North Carolina, South Carolina, Georgia, Florida, Illinois, Minnesota, South Dakota, Nebraska, Kansas, Tennessee, Alabama, Mississippi, Texas, and Colorado.

Augochloropsis cuprea (Smith), n. comb.

Augochlora cuprea F. Smith, Cat. Hym. Brit. Mus., **1**: 79. 1853.—Dalla Torre, Cat. Hym., **10**: 94. 1896.—Graenicher, Ann. Ent. Soc. Amer., **23**: 157, 167. 1930.

Augochlora fulgida F. Smith, Cat. Hym. Brit. Mus., **1**: 79. 1853.—Dalla Torre, Cat. Hym., **10**: 95. 1896 (new synonymy).

Augochlora viridula F. Smith, Cat. Hym. Brit. Mus., **1**: 81. 1853.—Cresson, Trans. Amer. Ent. Soc., suppl. vol., p. 293, 1887.—Dalla Torre, Cat. Hym., **10**: 97. 1896.—Cockerell, Ann. Mag. Nat. Hist., (7), **19**: 533. 1907 (new synonymy).

Augochlora fervida F. Smith, Cat. Hym. Brit. Mus., **1**; 81. 1853.—Robertson, Trans. Amer. Ent. Soc., **22**: 118. 1895.—Dalla Torre, Cat. Hym., **10**: 95. 1896.—Robertson, Canad. Ent., **29**: 64. 1897.—Cockerell, Canad. Ent., **38**: 162. 1906. (new synonymy).

Augochlora lucidula F. Smith, Cat. Hym. Brit. Mus., **1**: 81. 1853.—Dalla Torre, Cat. Hym., **10**: 95. 1896 (new synonymy).

?*Augochlora sumptuosa* F. Smith, Cat. Hym. Brit. Mus., **1**: 82. 1853.—Dalla Torre, Cat. Hym., **10**: 96. 1896.—Cockerell, Canad. Ent., **29**: 5. 1897 (new synonymy).

Augochlora (*Augochloropsis*) *lucidula* Cockerell, Canad. Ent., **29**: 4. 1897.

Augochlora (*Augochloropsis*) *cleomis* Titus, Canad. Ent., **33**: 135; fig. 6, 1901 (new synonymy).

?*Halictus* (*Augochlora*) *chorisis* Vachal, Misc. Ent., **11**: 136. 1903; **12**: 13. 1904 (new synonymy).

?*Augochlora chorisis* Cockerell, Trans. Amer. Ent. Soc., **31**: 361. 1905.

Halictus (*Augochlora*) *cupreus* Viereck, Rept. New Jersey State Mus., p. 688, 1910.

Halictus (*Augochlora*) *fervidus* Viereck, Rept. New Jersey State Mus., p. 688, 1910.

Halictus (*Augochlora*) *viridissimus* Viereck, Rept. New Jersey State Mus., p. 688, 1910. (Proposed for *Halictus* (*Augochlora*) *viridulus* F. Smith, not *Halictus* (*Agapostemon*) *viridulus* Fabricius) (new synonymy).

Augochlora fulvofimbriata Friese, Stett. Ent. Zeit., **77**: 315. 1916, female only (new synonymy).

Augochlora anonyma Cockerell, Proc. U. S. N. M., **60** (18): 15. 1922 (new synonymy).

Augochlora (*Augochloropsis*) *fervida* Cockerell, Univ. Colo. Studies, **16**: 101. 1928.

Type: Female, from North America, in the Oxford Museum, where it was seen by Mr. Benson and its identity confirmed by comparison of specimens

submitted by the writer. The types of *fulgida*, *viridula*, *fervida*, and *lucidula* are in the British Museum; their synonymy with *cuprea* was confirmed by comparisons in connection with notes and specimens submitted. The type of *sumptuosa* could not be located, but the synonymy tentatively made is based on a specimen in the British Museum identified by Smith. The type of *anonyma* is in the U. S. National Museum. The type and allotype of *cleomis* are in the collection of the Colorado Agricultural College, but the species can be identified with certainty from characters given in the description. A specimen of *fulvofimbriata*, labeled "typus" by Friese and in the National Museum, is identical with *cuprea*. The present location of the type of *chorisis* is unknown to the writer. This species varies in color in a manner similar to *caerulea* but is usually more golden green; it also differs in the angles of the pronotum, the less strongly elevated vertex, and the yellow tarsi of the male.

Distribution: In so far as is known, occurring throughout the eastern and central parts of the United States from New Hampshire to Florida and from South Dakota to Texas. It also occurs in Ontario, Canada, and the following Central American countries: Mexico, Honduras, Costa Rica, and Panama; but the distribution in these countries is yet inadequately known. Specimens have been examined from the following States: New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Ohio, Indiana, Illinois, Minnesota, Iowa, Missouri, South Dakota, Nebraska, Kansas, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas, Colorado, and Arizona.

Augochlora F. Smith

Augochlora F. Smith, Cat. Hym. Brit. Mus., **1**: 73, pl. III, fig. 10, 1853 (part) —Jour. Entom., **1**: 146. 1861.—Provancher, Natur. Canad., **13**: 205. 1882.—Petite Faun. Ent. Canad., p. 705, 1883 (part).—Robertson, Trans. Amer. Ent. Soc., **20**: 147. 1893 (part).—Dalla Torre, Cat. Hym., **10**: 93. 1896 (part).—Cockerell, Canad. Ent., **29**: 4. 1897 (part).—Robertson, Canad. Ent., **29**: 64. 1897 (part).—Cockerell, Trans. Amer. Ent. Soc., **24**: 162. 1897 (part).—Robertson, Canad. Ent., **29**: 176. 1897 (part).—Ashmead, Trans. Amer. Ent. Soc., **26**: 91. 1899 (part).—Cockerell, Proc. Acad. Nat. Sci. Phila., p. 374, 1900 (part).—Trans. Amer. Ent. Soc., **31**: 356. 1905 (part). *Genotype: Augochlora pura* (Say). (By designation of Cockerell, Ann. Mag. Nat. Hist., (9), **11**: 448. 1923).

Oxystoglossa F. Smith, Cat. Hym. Brit. Mus., **1**: 83, pl. III, figs. 8–9, 1853. —Robertson, Canad. Ent., **34**: 244. 1902 (part).—Schrottky, Deut. Ent. Zeit., p. 482, 1909. *Genotype: Oxystoglossa decorata* Smith (monobasic).

Odontochlora Schrottky, Rev. Mus. La Plata, **16**: 14. 1909.—Deutsch. Ent. Zeit., p. 482, 1909. *Genotype: Augochlora muelleri* Cockerell (original designation) (new synonymy).

Halicti falcati, groupe *Oxystoglossa* Vachal, Misc. Ent., **19**: 14. 1911 (part).

The synonymy of *Oxystoglossa* was first proposed by Ashmead (1899), and although I was unable to examine the genotype, *decorata* Smith, Mr. Benson verified the presence of certain diagnostic characters and confirmed this synonymy. Through the designation by Cockerell of *pura* as the genotype of *Augochlora*, both *Oxystoglossa* and *Odontochlora* become direct synonyms and can no longer be used, even as subgenera.

This genus is similar to *Augochlorella* in general appearance and color, but

differs as follows: Head broader, more gradually declivous to occipital carina, the carina strongly developed and continued to hypostomal carinae. Mandible of female apically bidentate, teeth subequal; inferior margin convex apically, varying specifically. Flagellum of male with joints beyond fourth progressively longer. Transverse suture of metapleuron carinate. Apex of radial cell truncate, with appendiculate vein. Lateral surfaces of propodeum deeply, contiguously punctured. Female: Inner surface of hind femur with a single row of long, curled, pinnately branched hairs (as in *Halictus*); first sternite usually with median carina or tooth, sixth with median triangular polished area. Male: First sternite with median furrow or carina, caudal margins of second to sixth truncate.

Male genitalia: In general structure similar to those of *Augochlorella*, but differing as follows: Coxopodites about as long as parameres. Distal portion of coxopodite with a subrectangular process which is directed medially, ventral surface without a plate-like process. An illustration of the entire genitalia is given for *A. pura* (Say), but for the others, only a ventral view of the distal portion of the coxopodite, as that portion varies the most between the species. (See Figs. 1, 2, 3, 7, 8).

KEY TO SPECIES OF THE UNITED STATES

1. Caudal margins of abdominal tergites black or tergites strongly melanic; wings somewhat fuscous, not at all yellowish; species bluish green, frequently with tendency to melanism also on head and thorax. Female: First sternite with median tooth; first tergite microscopically aciculate; mesoscutum anteriorly and laterally with contiguous punctures, posteriorly microscopically tessellate; median carina of labrum low, without basal notch. Male: Abdominal sternites 2 to 6 dull brown or black . . 2

   Caudal margins of abdominal tergites brownish; wings yellowish infumate; species golden or yellowish green with no tendency to melanism. Female: First sternite with median longitudinal carina or furrow; first tergite polished; mesoscutum and mesopleuron shining; median carina of labrum apically strongly elevated, basally notched. Male: Third and fourth abdominal sternites shining, strongly tinged with green . . 4

2. Transverse carina of metapleural suture strongly produced into a lamelliform process. Female: Tooth on first sternite, from lateral view, tapering but slightly to broadly rounded apex. Male: Labrum and mandibles reddish brown; clypeus unicolorous; third flagellar joint longer than broad, one and one-half times as long as second; first tergite apically with sides parallel, then narrowed rather abruptly to base, caudal margin constricted, punctures distinct, separated by about their diameter . . . . . *transversalis* Sandhouse & Cockerell

   Transverse carina of metapleural suture not produced into a lamelliform process. Female: Tooth on first sternite, from lateral view, tapering to narrow apex. Male: Labrum and mandibles yellow; apical margin of clypeus yellow; third flagellar joint broader than long, subequal to second; first tergite narrowed gradually to base, caudal margin not constricted, punctures rather indistinct, separated by at least twice their diameter 3

3. Disk of propodeum longitudinally carinate. Female: First tergite indistinctly punctured; mesoscutum medially with some scattered punctures nearly twice as large as the others. Male: Third flagellar joint and those distad distinctly longer than wide, apical joint nearly twice as long as

wide; first sternite with low median carina; caudal margins of second and third slightly convex medially; first tergite finely aciculate; tarsal joints dark brown.....*nigrocyanea* Cockerell

Disk of propodeum laterally with longitudinal, medially with very irregular carinae. Female: First tergite distinctly punctured; mesoscutum uniformly punctured. Male: Unknown.....*azteca* (Vachal)

4. Mesoscutum finely, uniformly punctured, the punctures separated by more than their diameter, interspaces strongly polished; disk of propodeum laterally and basally with longitudinal carinae, median apical portion with carinae nearly transverse, extreme apex not carinate, polished. Female: Median carina of first sternite obsolescent; angle of hypostomal carina strongly produced; flagellum distinctly paler beneath. Male: Third flagellar joint subequal to fourth, the joints distad as wide as, or wider than long, except that the apical joint is distinctly longer; abdominal sternites obscurely tinged with green.....
.....*aztecula* Cockerell

Mesoscutum more coarsely punctured, the punctures laterally nearly contiguous, medially separated by about their diameter, interspaces dull; disk of propodeum with slightly irregular longitudinal carinae reaching to apex. Female: Median carina of first sternite well developed; angle of hypostomal carina not produced; flagellum uniformly dark brown. Male: Third flagellar joint nearly one and one-half times as long as fourth, joints distad distinctly longer than wide; third and fourth abdominal sternites strongly tinged with green.....*pura* (Say)

Augochlora pura (Say)

Halictus purus Say, Boston Jour. Nat. Hist., **1**: 395. 1837.—Le Conte, Writ. Thomas Say, **2**: 773. 1859.

Augochlora pura F. Smith, Cat. Hym. Brit. Mus., **1**: 80. 1853.—Provancher, Natur. Canad., **13**: 206. 1882.—Faun. Ent., Canad., Hym., p. 706. 1883.—Dalla Torre, Cat. Hym., **10**: 96. 1896.—Robertson, Trans. Acad. Sci. St. Louis, **7**: 323. 1897.—Crawford, Proc. U. S. N. M., **45**: 243. 1913.—Blackman & Stage, Tech. Publ. 17, New York State Coll. For., Syracuse Univ., **24** (22): 198. 1924.—Graenicher, Ann. Ent. Soc. Amer., **23**: 157, 167. 1930.

Augochlora labrosa Robertson (not Say), Trans. Amer. Ent. Soc., **20**: 146. 1893.

Augochlora robertsoni Cockerell, Canad. Ent., **29**: 69. 1897.

Oxystoglossa pura Robertson, Canad. Ent., **34**: 246. 1902.

Augochlora banksiella (*pura* subsp. ?) Cockerell, Ann. Mag. Nat. Hist., (7), **19**: 533. 1907.

Halictus (*Oxystoglossa*) *purus* Viereck, Rept. New Jersey State Mus., p. 688, 1910.

Halictus (*Oxystoglossa*) *muelleri* Vachal, Misc. Ent., **19**: 45. 1911 (part) (new synonymy).

Halictus (*Oxystoglossa*) *astios* Vachal, Misc. Ent., **19**: 44. 1911.

Halictus (*Oxystoglossa*) *astios* var. (?) *fuscatipes* Vachal, Misc. Ent., **19**: 45. 1911 (new synonymy).

Augochlora mosieri Cockerell, Proc. U. S. N. M., **60** (18): 15. 1922 (new synonymy).

Augochlora palmarum Cockerell, idem, 1922 (new synonymy).

Types: Female and male, from the United States, probably destroyed, but the species can be placed with certainty from the description and the account of its habits. The type of *festiva* is in the British Museum, where it was compared with specimens of *pura* submitted by the writer. The types of *banksiella*, *mosieri*, and *palmarum* are in the U. S. National Museum and have been found to be identical with *pura*. The present location of the types of *astios* and its variety *fuscatipes* are unknown to the writer, but the characters given by Vachal definitely place them here. This species nests under the bark in decomposing sapwood of hickory and oak. It is the only species of the genus found in the United States outside of Texas. From other species of similar appearance the female may be readily distinguished by the median carina on the first sternite, the male by the strongly punctured sides of the propodeum and the truncate caudal margin of the fourth sternite.

Distribution: This species is distributed in the eastern and central parts of the United States from Massachusetts west to Minnesota and south to Texas and Florida. Specimens have been seen from the following States: Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, and Texas. It is also known to occur in Quebec and Ontario, Canada.

Augochlora aztecula Cockerell

Augochlora aztecula Cockerell, Ann. Mag. Nat. Hist., (7), **19**: 534. 1907.

Type: Female, from Tlacotalpam, Vera Cruz, Mexico, in Cockerell's collection. It can be separated from the other species of the genus occurring in the United States by the following: Apex of disk of propodeum polished; mesoscutum rather sparsely punctured, with interspaces strongly polished; carina of first sternite obsolescent in female; angle of hypostomal carina strongly produced.

Distribution: The only specimens taken in the United States that have been seen are from the region near Brownsville, Texas; the species apparently belongs to the Neotropical rather than to the Nearctic fauna.

Augochlora azteca (Vachal)

Halictus (*Oxystoglossa*) *azteca* Vachal, Misc. Ent., **19**: 45, 110. 1911.
Augochlora (*Odontochlora*) *azteca* Cockerell, Proc. U. S. N. M., **63** (8): 4. 1924.

Type: Female, from Mexico, is probably in the Musée National d'Histoire Naturelle, Paris. The female may be distinguished from *pura* and *aztecula* by the tooth on the first sternite and the black caudal margins of the tergites, from *transversalis* by the weaker carina on metapleural suture, and from *nigrocyanea* by the punctation of the tergites and the differences in the carinae on the disk of the propodeum.

Distribution: Apparently similar to that of *aztecula*. Reference to the occurrence of *azteca* in Lower California by Sandhouse and Cockerell (1924) was erroneous; the specimens mentioned there belong to *transversalis*.

Augochlora transversalis Sandhouse & Cockerell, new status

Augochlora azteca var. *transversalis* Sandhouse & Cockerell, Proc. Calif. Acad. Sci., (4). **13**: 338. 1924.

Augochlora azteca Sandhouse & Cockerell (not Vachal), Proc. Calif. Acad. Sci., (4), **13**: 339. 1924 [erroneous determination].

Type: Female, from La Paz, Lower California, is in the Museum of the California Academy of Sciences. In both sexes it can be readily separated from the other species of the genus by the lamelliform process on the metapleural suture.

Distribution: Although apparently limited to Lower California, the species is included here in order to show its relationship to *azteca* and to correct the distributional records for that species.

Augochlora nigrocyanea Cockerell

Augochlora nigrocyanea Cockerell, Trans. Amer. Ent. Soc., **24**: 144. 1897.
Augochlora (*Odontochlora*) *nigrocyanea* Schwarz, Amer. Mus. Novit., **722**: 6. 1934.

Type: Female, from San Rafael, Vera Cruz, Mexico, in the collection of the U. S. National Museum. It can be separated from the other species occurring in the United States by the following characters: From *transversalis* by the weaker carina on the metapleural suture, from *azteca* by the greater tendency to melanism and the more weakly punctured abdominal tergites; the female, from those of *pura* and *aztecula* by the toothed first sternite; the male, from *pura* by the dark abdominal sternites and from *azteca* and *aztecula* by the larger size and more slender flagellum.

Distribution: Apparently similar to that of *aztecula*.

SPECIES NOT RECOGNIZED

Augochlora obliqua Provancher

Type: Female, from Vancouver, in the Musée de la Province de Quebec. Upon comparison by M. Comeau with material submitted by the writer, it could not be recognized as belonging to any of the known species of the genera considered in this paper; nor are these known to occur in that region. It may be referable to *Agapostemon*, but further information on the type is necessary before a definite assignment can be made.

MALACOLOGY.—*A new species of* Melania *from Szechuan Province, China.*[1]

SUI FONG CHEN. (Communicated by PAUL BARTSCH.)

In a collection of Chinese fresh water mollusks received by the U. S. National Museum from the Rev. D. C. Graham is an undescribed species which is here named.

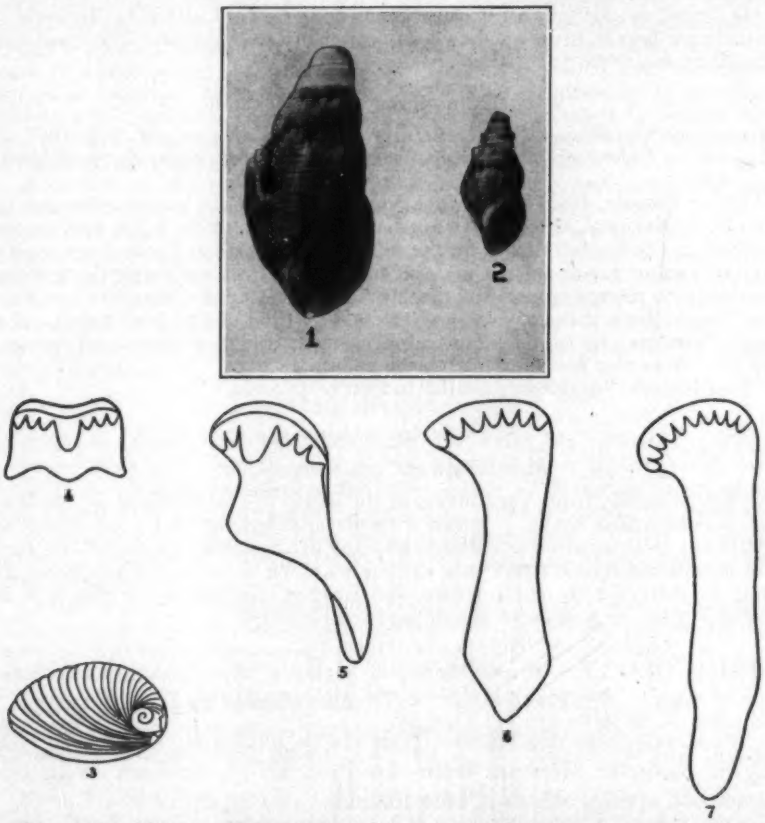
I wish here to express my appreciation to the authorities of the U. S. National Museum and to Dr. Paul Bartsch, the Curator of the Division of Mollusks, for the privilege of studying the Chinese Melanias in their collection.

Melania (Plotiopsis) grahami, n. sp. Figs. 1–7

Shell thin, elongated, ovate, turreted, greenish yellow with more or less irregularly interrupted reddish brown axial bands which are most conspicu-

[1] Published by permission of the Secretary of the Smithsonian Institution. Received December 16, 1936.

ous on the last whorl and the base, and may be seen in the aperture. Nuclear whorls eroded in all the specimens before me. The type has 4.5 whorls remaining, which are moderately convex and angulated at the anterior end of the concave shoulder. Thirteen axial ribs are present on all the postnuclear whorls. They are most prominent on the last and the penultimate whorls,



Figs. 1–7.—*Melania* (*Plotiopsis*) *grahami*, n. sp. 1, holotype, 2, young specimen, ×3; 3, operculum, ×7; 4, rachidian tooth, 5, lateral tooth, 6, inner marginal tooth, 7, outer marginal tooth, ×500.

evenly spaced, and project conspicuously at the shoulder as spinose tubercles continuing feebly across the shoulder to the summit. The spiral sculpture consists of lirations, of which 6 are present on the shoulder between the suture and the summit; 13 between the shoulder and the periphery on the last whorl and 10 on the base. Those on the base are the strongest, next to this are those between the shoulder and the periphery, while those between the suture and the summit are the least strong. Suture strongly constricted. Periphery of the last whorl well rounded. The aperture is elliptical; the peristome

thin, slightly expanded, and adnate to the preceding turn at the parietal wall, which is glazed with a thin callus. The columella is arched, and calloused almost to the base with a grayish white deposit. The operculum is thin, elliptical with 2.5 turns and with subcentral nucleus. The radula has the formula: 3–1–3 : 2–1–3 : 7 : 10.

The type, U. S. N. M. Cat. No. 467600, was collected by Rev. D. C. Graham at Me-wang, Lam-ping, Szechuan Province, China, and gives the following measurement: No. of whorls, 4.5; height 14.2 mm; diameter 7.0 mm; length of aperture 6.1 mm.

Thirty-eight specimens derived from the same source from which the type was obtained, yield the following additional information: They have an average number of 4.8 whorls; the greatest number of whorls is 5.9, and the least 3.7. They present an average height of 9.7 mm; the greatest height is 12.2 and the least 7.1 mm. Their average diameter is 5.0 mm; the largest 6.2 and the least 3.5 mm. The length of the aperture averages 4.2 mm; the largest length of aperture is 5.3 and the least 2.9 mm.

This species most nearly resembles *Melania balonnensis* Conrad, from southeastern Australia. It differes from it in being a little smaller and more ovate.

ORNITHOLOGY.—*A new genus for* Pseudoptynx solomonensis *Hartert.*[1] JAMES L. PETERS, Museum of Comparative Zoology, Harvard University.

The name *Pseudoptynx* was proposed by Kaup in Oken's *Isis*, 1848, col. 770 for the segregation of *Syrnium philippense* Gray. However the generic name was without diagnosis and the name of its single included species was a nomen nudum, hence *Pseudoptynx* is not nomenclaturally available from this citation. In the Archive für Naturgeschichte, **17**, Bd. 1, 1851, p. 110, Kaup validated both his own generic name and Gray's nude specific name; *Pseudoptynx philippensis* therefore dates from 1851 and the authority is Kaup.

Tweeddale described *Pseudoptynx gurneyi* (Proc. Zool. Soc. London, 1878, p. 940, pl. 58) from Mindanao; Hartert named *Pseudoptynx solomonensis* (Bull. B. O. C., **12**, 1901, p. 25) from Ysabel Island, Solomon Islands; and lastly Ogilvie-Grant added *Pseudoptynx mindanensis* (Bull. B. O. C., **16**, 1906, p. 99) with type locality southeastern Mindanao. *P. mindanensis* is conspecific with *P. philippensis;* Hachisuka has proposed *Mimizuku* (Bds. Phil. Ids., pt. 3, 1934, p. 50) as a monotypic genus for *P. gurneyi* and in this paper I advocate the generic separation of the Solomon Island bird. *P. philippensis* and *M. gurneyi* belong to the subfamily Buboninae in which the external ear opening is small, dermal ear flaps absent and ear opening not crossed by a ligamentous bridge.

Hachisuka was quite right not only in removing *Pseudoptynx gur-*

[1] Received January 27, 1937.

neyi Tweedd. from *Pseudoptynx*, but also in creating a monotypic genus for it. The bird is not at all closely related to *P. philippensis*, but is far more closely related to *Otus*. In diagnosing *Mimizuku*, Hachisuka gave only the characters that could immediately distinguish it from *Pseudoptynx*. Compared with *Otus*, *Mimizuku* stands out by reason of its larger size; bill with culmen strongly rounded, upper mandible decidedly convex in lateral outline (viewed from above) with distinct festoon or tooth on cutting edge; feet and claws relatively and absolutely larger and stronger than in even the largest species of *Otus;* wing very much rounded, longest primaries exceeding secondaries by little more than one-half the length of tarsus; outermost primary shorter than 10th, 2nd shorter than 9th, 5th longest; frontal feathers, ear tufts, emargination of primaries and tarsal feathering as in *Otus*. *P. solomonensis* on the other hand is not a bubonine owl at all, but belongs to the Striginae, characterized by a large auricular opening with well developed dermal ear flaps and crossed by a ligamentous bridge. It may be called

Nesasio, n. gen.

A medium sized strigine most nearly allied to *Asio* Birsson, but body plumage more decomposed and silky; feet and claws extremely large and powerful; tarsi feathered; toes naked; middle toe three-fourths length of tarsus (about one-half in *Asio*); claw of inner toe longer than claw of middle toe (reverse in other species of *Asio* except *madagascariensis*); bill very stout and heavy with culmen arched and strongly decurved; nostril more rounded less oval; wing much rounded; the longest primaries exceeding the tips of the secondaries by less than 20 mm; 4th? primary longest (by a strange coincidence the distal portion of 5th primary is missing in both wings of the single specimen available); outer primaries weakly emarginated; bristles at base of bill strong, though relatively not as well developed as in *Asio;* no trace of ear tufts. Two other characters noted may be due to the preparation of the skin, namely, facial disc not clearly defined; eyes much larger.

Type, *Pseudoptynx solomonensis* Hartert.

This genus is probably derived from an offshoot of *Asio flammeus* stock, the underlying color pattern of both suggesting this probable ancestry; its sedentary habits and insular habitat have resulted in a considerable shortening of the primaries, at the same time there has been a development in size of bill and feet, these members greatly exceeding in strength the corresponding parts of those representatives of the genus *Asio* characterized by strong bill and feet, namely *abyssinicus*, *madagascariensis* and *helvola*. *A. madagascariensis*, which is undubitably an offshoot of *A. asio*, also exhibits a tendency towards larger bill and feet and more rounded wing, but the characters are not sufficiently marked in this instance to warrant generic separation. An even closer parallelism is found in *Pseudoscops*, a monotypic genus confined to the Island of Jamaica. This bird, originally of *A. asio* stock, also

has the increased size of bill and feet coupled with much shorter wing tip and weakly emarginated primaries.

In concluding I feel that a word of explanation is in order concerning feathering on tarsi and toes as a generic character in owls. Especially as regards the toes, my feeling is that this character is of subspecific importance, but no more. Of the genera confined to the tropics, practically not a single species has feathered toes, though in many cases the dense tarsal feathering ends abruptly at the base of the toes. On the other hand all the olarctic genera invariably have feathered toes, *Nyctea* being an example of extreme development in this direction. Where a genus is widely distributed with representatives in both temperate and tropical regions the feathering on the toes of the tropical forms varies from sparse to bristly and in some species of *Otus* for instance, the toes are quite bare. Among the Strigidae it therefore seems best to drop the feathering of the toes as a generic criterion, since it not only is of no generic significance, but its use in the past has resulted in the wrong allocation of species in their systematic position.

Thanks are due to Dr. Witmer Stone of the Academy of Natural Sciences for the loan of a specimen of *Mimizuku gurneyi* (Tweedd.) and to Dr. Ernst Mayr for the loan of a specimen of *Nesasio solomonensis* (Hart.).

Obituary

FREDERICK VERNON COVILLE, botanist in the U. S. Department of Agriculture since 1888, and an ex-president of the Academy, died of coronary thrombosis at his home, 1836 California Street, on January 9, 1937, after a brief illness. Dr. Coville was born at Preston, N. Y., on March 23, 1867. He received his A.B. at Cornell University in 1887, and the honorary degree Doctor of Science from George Washington University in 1921. After serving as instructor in botany at Cornell in 1887–88, he entered the U. S. Department of Agriculture as assistant botanist in 1888, becoming botanist in 1893 on the death of Dr. George Vasey, senior botanist in 1924, and principal botanist in 1928. When the present Bureau of Plant Industry was established in 1901, he became the head of the Office of Botanical Investigations and Experiments (later, after various transient changes in title, the Office of Economic and Systematic Botany, still later the Division of Botany), a position he held until the office was merged in 1934 into the Division of Plant Exploration and Introduction. He became curator of the National Herbarium in 1893, and so continued after its transfer to the custody of the Smithsonian Institution in 1896. He was active in promoting the establishment of a National Arboretum, and was acting director from 1929, when the project took definite form.

Dr. Coville's first professional field work was as botanical assistant in the Arkansas Geological Survey in 1887, resulting in the publication of *A List of the Plants of Arkansas* (by J. C. Branner and F. V. Coville) in 1891, which is still the only list of the plants of that state. His most important field work was as botanist of the Death Valley Expedition in 1891, the results of which were published in 1893 as *Botany of the Death Valley Expedition*. For several years prior to his death he had again been active, in cooperation with M. French Gilman, in the collection and study of the plants of Death Valley,

and was preparing a popular flora of that region. In 1899 he and Dr. T. H. Kearney were botanists of the Harriman Expedition to Alaska. Although he described new plants in many other families, his taxonomic interests were primarily in the Juncaceae, in which he was the recognized American authority, and the Grossulariaceae, of which, in collaboration with Dr. N. L. Britton, he prepared the treatment for *North American Flora*. From almost the beginning of his career he was interested in the useful plants of the North American Indians, and he published several papers on this subjects.

Through his position in the Department of Agriculture from an early date, and through his association with the National Geographic Society and the Carnegie Institution, Dr. Coville's influence in practical problems of agriculture and forestry was extensive. The foundation, in 1903, of the Desert Botanical Laboratory of the Carnegie Institution at Tucson, Arizona, was largely due to his efforts. As Chairman of the Research Committee of the National Geographic Society for many years, he was influential in its choice of fields for exploration. In the Department of Agriculture he was instrumental in the formation of the Seed Laboratory with its seed investigations and in the initiation of grain-grading investigations. He formulated the policy for the use of National Forests as grazing lands which, with minor changes, is in effect today.

Dr. Coville's most important recent work in economic botany was concerned with the blueberry, which he developed from a wild fruit into a cultivated crop of commercial significance in the acid, sandy soils of our eastern coast. The largest berries produced by his plants, after 30 years of cultivation and hybridization, reached 25.9 mm in diameter, contrasting with the 12–15 mm maximum of their wild progenitors. In connection with his cultivation of blueberries, he demonstrated that this group and many other Ericaceae require acid soils for proper development. His work with cultivated plants led also to the scientific recognition of the importance of a period of chilling temperature for the normal flowering and fruiting of plants of the temperate zone. With assistance from members of his office, particularly W. F. Wight, he prepared or rewrote the botanical definitions in the supplementary volumes and the revised edition of the *Century Dictionary;* he had also taken an active part, under Dr. Lester F. Ward, in the preparation of the definitions in the first edition. With F. L. Olmsted and H. P. Kelsey, he was coauthor of *Standardized Plant Names*, a work which sought to establish standard names, both scientific and vernacular, for the plants in the North American nursery trade.

Dr. Coville was president of the Biological Society of Washington in 1899–1900, of the Botanical Society of America in 1903–04, of the Washington Academy of Sciences in 1912, of the Cosmos Club in 1915, of the Washington Biologists' Field Club in 1919–21, and of the Arts Club of Washington in 1927–29. In 1903 he was vice-president of the American Association for the Advancement of Science. He received the George Robert White Medal of Honor from the Massachusetts Horticultural Society in 1931, in recognition of his outstanding work with blueberries.